JULY

# THE JOURNAL OF THE AMERICAN DENTAL ASSOCIATION

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COUNCIL ON DENTAL THERAPEUTICS
Annual Meeting

BUREAU OF PUBLIC RELATIONS
What It Means to Be a Dentist—*Blauch*

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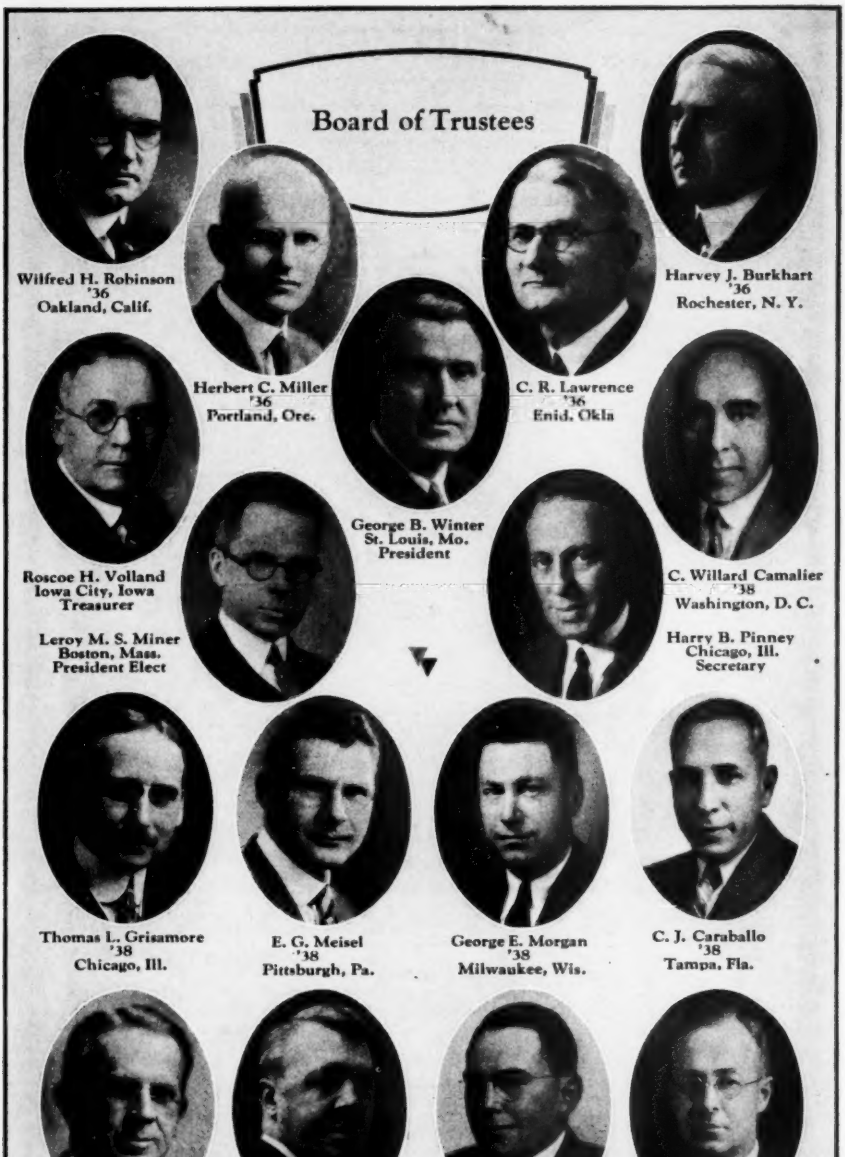


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THE JOURNAL
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## Original Communications

# DIAGNOSIS AND EVALUATION OF TREATMENT IN PERIODONTOCLASIA*

By WILLA YERETSKY, D.D.S., Grand Rapids, Mich.

PERIODONTAL diseases have long been the step-children of dentistry. For the most part, dentists have treated them only as a very distasteful duty and without enthusiasm. This has been due in part to a lack of proper evaluation in dental colleges and in part to a lack of success in the treatment of these diseases. Many dentists take postgraduate courses in surgery, crown and bridge work, prosthodontia, ceramics and orthodontia, yet relatively few seek more extensive training in periodontia. It is extraordinary that, with the great strides made in reparative dentistry in the last decade, so little interest has been shown in the supporting tissues, the loss of health of which means a waste of skilful restorations, with the loss of the teeth themselves. Yet, so far, rather than pursue the study of the organic tissues of the oral cavity and their healthy maintenance, many operators have delegated this most important of all branches of the dental art, most important because it is the basis of maintaining the masticating function, to young women who are not even dentists, but merely operating assistants or dental nurses. Only indifference based on a lack of understanding can account for such a situation. Hence, it behooves us to work for a better understanding of what constitutes periodontoclasia and how best to treat it.

"Periodontoclasia" is a term used in dentistry to indicate a progressive destruction of the tissues immediately surrounding the teeth. This term supplants the old "pyorrhea alveolaris," which lacks accuracy in its designation.

Periodontoclasia embraces three types of pathologic change, any one of which may be recognized as a distinct clinical picture or all of which may be so intermingled as to make diagnosis difficult. These types may be classified according to

*Read before the Section on Periodontia at the Seventy-Seventh Annual Session of the American Dental Association, New Orleans, La., Nov. 6, 1935.

Merritt as marginal gingivitis, periodontoclasia, suppurative and nonsuppurative, and diffuse alveolar atrophy.

Marginal gingivitis and periodontoclasia are most frequently of local origin. From 90 to 95 per cent of periodontal lesions fall into this group. They are very amenable to treatment. Diffuse alveolar atrophy is of more obscure etiology, but is generally supposed to be systemic in origin. This group comprises a much smaller percentage of cases and is much more resistant to treatment.

Marginal gingivitis is characterized by swelling and inflammation of the gingivae, which bleed very easily, sometimes spontaneously. There may or may not be suppuration. Usually, if the disease has been in progress for some time, there is suppuration. If the disease has been in progress so long as to become chronic, the gingivae may become extremely hypertrophied. The swelling of the gingival tissue seems greatest in the interproximal spaces. Because of the swelling, the depth from the crest of the gingiva to the bottom of the gingival crevice is increased so much beyond normal as to apparently be a pocket.

Chronic marginal gingivitis is characterized by a deposit on the surfaces of the teeth that may be a tenacious, viscous material in a soft condition or a hard, calcareous deposit, or both. It occurs only on the portion of the tooth that is detached from the gingival tissue, but it may be subgingival or supragingival.

Normally, the gingival crevice surrounding a tooth is very shallow, being from 1 to 3 mm. in depth. Any conditions that cause a break in the gingival epithelium, with consequent detachment from the root surfaces, are factors in periodontoclasia.

As the detachment of the gingival tissue progresses, the periodontal fibers are detached from the cementum and a pocket is formed. These pockets are characteristic of periodontoclasia. There may be but a single one in an entire mouth or they may be found in practically the entire alveolar area. A pocket may occur on but one side of a tooth only or may involve the entire tooth. Pockets in the same mouth may vary from a few millimeters to the entire length of the root.

The causes of marginal gingivitis and periodontoclasia are similar. They are deposits of calculus, supragingival and subgingival, faulty restorations, bacterial invasion, occlusal stress and systemic conditions such as nutritional and metabolic disturbances and metallic poisoning.

The diagnosis and differential diagnosis of these causes are of the utmost importance. A fine probe or explorer and a trained eye are all that are necessary for diagnosis.

Supragingival calculus is obvious. The yellowish white rough material impinging on the gingival border can be seen with the naked eye. If it is extensive, the calculus may protrude into the gingival crevice, that part of it under the margin being black and of the serumal variety. Very often, owing to careful personal hygiene, subgingival calculus will be present without supragingival. It is this hidden calculus which, more than any other one single factor, is responsible for failure of the treatment of gingivitis and periodontoclasia. Often this subgingival calculus clings to the root of a tooth in fine, shalelike formation, not more than 1 mm. in thickness, defying exposure by even the roentgen rays. This *can* be detected by noting the color and thickness of the gingival border. There will be the slightest thickening of the gingival border, a lack of sheen on the mucous membrane and the faintest purple shadow. The heavier the deposit, the more pronounced the purple shadow and the greater the swelling. A fine probe will

replacement
return direct



aid in finding this hidden deposit. The operator must be able to determine what a normal, smooth root surface feels like and the difference between it and the rough calculus.

A purple or black line at the edge of the gingiva with some swelling is characteristic of metallic poisoning: lead, bismuth or mercury. The differential diagnosis may be made on the history of the intake of these drugs and on the findings with the probe.

A careful check must be made to determine whether the patient is ingesting the metal as a therapeutic measure or he is receiving it in the line of his occupation. In either case, the source must be immediately eliminated.

More often than we like to acknowledge, faulty dental restorations are a cause of periodontal disease. Amalgams pushed in with a finger and the excess left on the gingival tissue, lack of contact between crowns, etc., allowing food to pack down into and to disintegrate on the interdental papillae, and margins of inlays and crowns that project into the interdental spaces all cause irritation to the tissue. The explorer or probe can soon determine these defects.

Bacterial invasion is an important factor also in marginal gingivitis and periodontoclasia. Infection always follows long-continued inflammation. Bacteria that play the part of secondary invaders may multiply so rapidly as to become of primary importance. An acute gingivitis may be caused by a primary infection by the streptococcus or the staphylococcus. This is usually marked by pain and fever. There will also be pitted erosions of a painful character on the buccal and palatal membranes. Vincent's organisms are also important bacterial invaders. The acute picture with necrotic ulcerations along the gingival border is too well-known to need description. It must be differentiated from blood-stream dyscrasias. In differentiating, it must be borne in mind that all necrotic areas in the mouth will have some Vincent's organisms on them, as these organisms are saprophytes. Vincent's infection may become chronic and hasten the formation of pockets. This condition may be recognized by the punched-out appearance of the tissue between the buccal and lingual walls of the gingivae and the texture of the pus. There is little, if any, odor in chronic Vincent's infection.

Smears and cultures of oral bacteria are of value only as to quantity. The Vincent group and *Streptococcus viridans* are the most usual. If one predominates entirely over the other, that one may be responsible. Often, both the streptococcus and the Vincent organism together may be the causative factor, and both must be treated.

In Vincent's infection, neo-arsphenamine in glycerine is the drug of choice. If the streptococcus is the predominating organism, an aqueous solution of metaphen will be found effective. Vastine recommends a 5 per cent aqueous solution of mercurochrome as a streptococcicide. Where both groups are involved, he advises using first mercurochrome, following with neo-arsphenamine in glycerine.

The ultraviolet rays have been greatly extolled in the treatment of bacterial invasion and periodontal lesions of the oral cavity. To be of any benefit, it is necessary to produce an erythema dose. This causes a blistering of the mucous membrane sufficient to lower resistance and hamper recovery. Hirschfeld states that, after two years of careful experiments with ultraviolet rays applied directly to the oral tissues, he believes that its use is unwarranted.

Occlusal stress or traumatic occlusion plays a large part in periodontal lesions. The extraction of molar teeth at an early

age allows undue stress to fall on the anterior teeth; which produces pockets on the lingual aspect of the lower anterior teeth and on the labial of the upper anterior. There will also be pocket formation on the sides of the teeth in the direction in which they are tipping. Hence, it is essential that properly constructed bridges be inserted after extraction in order to prevent this occurrence. Trauma is also produced by crowns, etc., that are too high, by too sharp cusps on restorations and by natural cusps that have not been normally abraded.

It will be noted that the roentgen rays have not been mentioned as an essential in diagnosis of marginal gingivitis and periodontoclasia. The value of a roentgenogram has been greatly overestimated in the diagnosis of oral lesions, and it behooves dentists to use the eyes and sense of touch to discover conditions regarding which a roentgenogram may be very misleading. Several years ago, a woman, aged 55, was referred to an oral surgeon by her physician for extraction of all her remaining teeth because of "pyorrhea." The roentgenogram showed a resorption of all the alveolar crests as though a horizontal line had been drawn through the alveolar bone several millimeters below the cemento-enamel junction. The surgeon, a man of broad experience, refused to extract the teeth and referred the patient to a periodontist. The physician had taken the roentgenologist's report without even looking into the mouth. The gingival tissue was perfectly healthy, there being no inflammation and no suppuration. There was simply a natural resorption due to the patient's age and to the amount of occlusal stress. The marginal gingiva was thin and hugged the tooth firmly. A probe could not be introduced for more than 1 mm. A great injustice would have been done this patient had her teeth been removed. This is only one of innumerable instances wherein a wrong or inaccurate diagnosis has been made not only by physicians but also by dentists, on the basis of roentgen-ray findings only.

Kronfeld emphasizes the folly of diagnosing pockets from a roentgenogram. He writes:

> A pocket is determined by the attachment of the soft tissue, not of the bone. The only thing that can actually be seen in the routine radiograph is the amount of bone present; the supposition that the loss of bone and formation of a pocket must necessarily go hand in hand is not substantiated by the actual examination of the tissues involved.

Diffuse alveolar atrophy is characterized by a loosening and wandering of the teeth. It is considered by Gottlieb a primary bone disease, the cause of which is unknown. The cause seems to be systemic and is probably metabolic. The microscopic findings show resorption of both root surfaces and alveolar bone with marked widening of the periodontal spaces. These processes do not necessarily occur from the gingival crevice down as in periodontoclasia, but may occur around the apical two-thirds of the root with the gingival margin intact. There may be very little subepithelial inflammation. The bone at the alveolar crest may be intact. Clinically, the teeth may loosen and extrude owing to the destruction of the periodontal fibers.

In general, the same type of treatment prevails locally for all three types of periodontal disease: marginal gingivitis, periodontoclasia and diffuse alveolar atrophy. After ruling out the faulty restoration, occlusal stress and bacterial invasion, the essential need is to remove all calcareous deposits, as well as granulation tissue and débris from the gingival crevice and extending into any pocket. The thoroughness with which this is done is the greatest factor in the successful cure of periodontal lesions.

There are two general methods for accomplishing this result: (1) subgingival curettage, known as the conservative method; and (2) the surgical removal of all tissue forming the pocket, known as the radical method.

Subgingival curettage consists of inserting suitable instruments beneath the margin of the gingiva as far as the detachment from the tooth extends, in such manner as to remove all calcareous and granulomatous material. There are several types of instruments for this purpose. Each operator must find for himself what constitutes the most effective type in his hands. In general, these instruments fall into three groups, curets, files and planes. It is essential that whatever instruments be used be adequate in number and design to reach any portion of a tooth, and they must be sharp. As Merritt says, "To undertake treatment, as is sometimes done, with a group of dull, ill-assorted instruments, is to invite defeat." Subgingival curettage must be accomplished entirely by a sense of touch as the field of operation is out of sight. Hence, a keen and delicate sense of touch must be cultivated. The instrument is inserted between the tooth and the detached gingiva in such manner as to fit as closely as possible to the tooth surface. In this way, a minimum of trauma and pain will ensue. By fitting the tooth carefully, the instrument can be moved back and forth to remove any foreign material. This is where the sense of touch is so important because, if too much pressure is put on the instrument, the root will be gouged, and, if too little, all the calculus will not be removed. Moreover, it is necessary to remove not only the calcareous deposit, but also all necrotic remnants of the periodontal fibers and any other pathologic tissue. For a successful result, it is necessary to have the cooperation of the patient in the way of brushing and massaging. When curettage has been adequately carried out and the gingiva has been properly stimulated, it will harden and shrink until the underlying alveolar process is covered closely and the pocket obliterated. Suppuration will cease as if by magic. Even hypertrophied tissue will shrink to normal when this treatment is thorough.

Subgingival curettage is always the method of choice in the treatment of marginal gingivitis. Here, the pockets are shallow and the tissue is highly inflamed. Immediate and gratifying response will be found to this method of treatment.

In the treatment of periodontoclasia, there has been growing an enthusiasm for radical surgical measures; i.e., obliteration of the pockets by removal of the tissue walls forming them. This operation entails all that operation elsewhere in the body does: general systemic shock, pain, uncomfortable convalescence, etc. It has the advantage of making the field of operation visible.

There are three recognized methods of operating:

1. Gingivectomy or gum resection. In this method, the gingival tissue is cut away to below the level of the involved alveolar process. Thus, an open space is created where no débris can lodge, but that portion of the root which was protected by the tissue is left exposed. These roots often are very sensitive when exposed and the patient suffers considerable discomfort. Moreover, the operation is so disfiguring as to be warranted only in the posterior portion of the mouth.

2. The flap operation, which, as described by Merritt, is more or less limited to the buccolabial surfaces of the gums, and has the advantage over the resection method of being less disfiguring. It is most often practiced in the incisor

region where there are several deep, narrow pockets. In this method, two vertical incisions extending from the depth of the pocket to the gingival border are made, the septal gingivae are divided and the labial flap is laid back, the anterior surfaces of the four or five teeth to be operated on being exposed. Access can usually be had to the lingual surfaces without the vertical incisions. The root surfaces are curetted, any unhealthy tissue that may be present is generally removed and the flap is brought back into place and sutured. The sutures should be allowed to remain for three or four days or until union has taken place. The same operation is also applicable to the bicuspid and first molar regions, especially in the upper jaw. In those cases also wherein there is a deep, narrow pocket about an individual tooth, a single incision parallel with the root can be made, extending from the border of the alveolar process to the orifice and dividing the pocket midway between its anterior-posterior boundaries. In this way, direct access to the pocket is gained. After the root surface has been curetted, the divided tissues are brought into apposition, where they will usually reunite without suturing. In such cases, there is occasionally a slight recession following healing, though this is never sufficient to cause disfigurement.

3. The modified flap operation, which consists of dividing the septal gingiva and in this way exposing the field to be operated in. It is especially applicable to the bicuspid and molar regions. At the conclusion of the operation, the buccolingual gingival areas are brought into apposition and sutured at the point of incision between each tooth. The operation is much the same as the flap operation without the vertical incision, and yields the maximum of results with a minimum of disfigurement. The gum recession following this operation is less evident than in either of the other types of operations, though always greater than that attending subgingival curettage.

Exactly the same thoroughness in removal of calculus and débris, with a smoothing of the root surface, must be accomplished, by either the subgingival curettage method or the surgical method. The same etiology obtains and the causes must be removed for either method to be successful. Also, the same follow-up methods must be employed. It is more difficult to keep the mouth clean after surgical procedure and the need for regular prophylactic treatments must be emphasized.

It is interesting to note some of the reasons given for favoring the radical procedure. In a well-known university, the only lectures on the radical surgical method of treatment given to the senior class of dental students were presented by a professor of oral surgery, a man with no experience in periodontia. He stated that radical surgical procedures were indicated when (1) cases do not respond to the conservative method, (2) there is a large amount of bone resorption with very little recession of the gingiva following the conservative treatment, (3) a wall of tissue remains and the interproximal surfaces cannot be cleaned, (4) there is hypertrophy of the gingiva and (5) the patient cannot afford to employ the conservative method. He states that it is a short cut and suggests that if the dentist is too busy with other work to employ the conservative method, he is justified in following the surgical. He feels that the method is inadvisable when over one-half the bony support of the tooth is lost or the disease has progressed into the bifurcation of the multirooted teeth. In these cases, he recommends extraction. Yet it is just these borderline or questionable cases that Merritt and other periodontists think justify surgical measures, and

then as a last resort. Cases in which there is less involvement will respond favorably to the conservative method.

Kaiser states that surgical intervention is indicated when time is short and the elimination of the focus of infection is necessary to forestall systemic involvement.

These reasons are typical of all advocating the radical method.

Let us consider individually the reasons given by the professor just mentioned for radical surgical methods. Obviously, when a case fails to respond to one method of treatment, another is justified before resort is had to extraction. Before one operates, the field should be as clean and free from infection as possible. In order to accomplish this, calcareous deposits should be removed as far as possible and the tooth surfaces polished. Often, after this is accomplished, such marked improvement will have taken place as to discourage surgical procedure. Pushing instrumentation further, then, to remove all deposit thoroughly will cure the condition, with the gingival tissue intact.

The second reason for using surgical intervention was "when a large amount of bone is gone from the interproximal spaces and the tissue forming the pocket had not atrophied to cover the interproximal space snugly." The gingival tissue will always cover the space snugly if apoxesis and after stimulation are thoroughly carried out. It is only when curettage is not adequate that the tissue fails to shrink.

Box states that he has histologic proof that reattachment of the soft tissues to the cementum can and does occur after subgingival curettage properly and thoroughly done. He also presents evidence of regeneration of bone around the teeth following peridental destruction, quoting such authors as Merritt, T. Sidney Smith and Stillman and McCall as agreeing with him. Kronfeld expresses skepticism as to reattachment of the soft tissues from an exact histologic standpoint. He feels that since the wall of the pocket shrinks after treatment, the reattachment is apparent rather than real. Moreover, Kronfeld believes that after the root surface has been exposed over a long period, it becomes a dead surface, stripped of all living cells down to the bottom of the crevice. As epithelium lines the soft tissue in the pocket in long continued chronic cases, he believes that it is difficult to get a reattachment of the connective tissue, that even if the wall is stripped of epithelium, there are likely to remain a few cells at the very bottom of the crevice which will proliferate and prevent reattachment. I doubt that any periodontist of experience will agree with Dr. Kronfeld. All who have had any measure of success have seen gingival tissue become firm and grow to fill an embrasure, once destroyed. Clinically, it is impossible to insert a fine probe between this tissue and the tooth and there is no exudate. The disease is arrested and the condition improves. This result can be assured only by subgingival curettage. The epithelial lining is curetted away, as well as the calculus and other débris, and an apparent reattachment occurs. If there is no recession of the gingiva after this treatment, it has not been performed properly. The patient's cooperation is necessary in this as well as in surgical treatment.

The next reason given by the professor of oral surgery mentioned above was that radical surgical measures are indicated when a wall of tissue remains and the interproximal surfaces cannot be cleaned. This condition rarely if ever arises from periodontoclasia. Even in periodontoclasia of long standing, the form of gingival tissue remains and will

not be destroyed. Destruction of the interproximal tissue of the interdental spaces, with a large wall remaining lingually and labially, occurs only where bacteria have played a large part, notably the Vincent group. In these cases, destruction of the cementum does not occur for some time, and persistent cleanliness on the part of the patient will soon allow the interproximal tissue to regenerate. If this wall is removed by operation, there are large, ugly spaces left in the embrasures, which can never be filled in.

In hypertrophy of the gingiva, when surgical operation is also recommended, a cause should be sought very carefully before resorting to surgical measures. The cause may be systemic, in which case the condition would recur even after removal. The hypertrophied tissue may be malignant and treatment would then require such extreme measures as may be necessary to prevent a recurrence of the neoplasm. Infective hypertrophy may be reduced by eliminating the infection and following with massage.

The last reason, and one which is given by many operators, is that the radical surgical procedure requires less time than the subgingival curettage and is therefore less expensive than the more conservative method; that is, it is a short cut for the general practitioner. This is fallacious. In reading several discussions of methods of radical operation, much is said about directions, preoperative and postoperative, to the patient. Many operators believe that the patient should be hospitalized for several days; all consider it essential that the patient rest in bed after operation. Nearly all the more recent articles recommend a thorough cleaning of the field, with superficial scaling and careful instruction to the patient before operation. This constitutes the preoperative treatment. One man gives his patients a printed leaflet on postoperative care, referring in detail to rest and advising the patient to stay in bed for three days (though he states that certain patients are able to return to work in three days); laxatives; diet (which must be confined to soft foods for a week at least); mouth washes; pain and fever; teeth and gums, hemorrhage, and loss of weight. No operator ever takes less than forty-five minutes for the actual operation in one quadrant of the mouth, and generally considerably more time is necessary. This does not include the time necessary for preparation of the patient and for anesthetizing. All operators emphasize the need for regular frequent prophylactic care, with cooperation and education of the patient for the future.

Six months ago, a patient was obtained for a radical periodontal operation, as a clinical demonstrations. This patient had been treated by a man skilled in mechanical restorations and honest in his desire to arrest the progress of the periodontoclasia in his patient's mouth. He had spent considerable time in attempting to remove deposits from the roots of the teeth, but suppuration persisted, and he felt that the only treatment which could save the teeth was radical operation. He, therefore, obtained the patient's acquiescence to submit to the operation as a clinical demonstration. It was very obvious to a trained periodontist that there were subgingival deposits of calculus remaining in the pockets which could be removed readily with proper instruments and technic, without resorting to surgical measures. It was arranged that one quarter of the area, the right half of the maxilla, be treated radically, and that the left half be treated conservatively at a later sitting, as the right half healed. A comparison could then be made of time involved in the operations, time of healing, discomfort, etc. The patient's mouth

was not specially prepared previously because it had been under treatment. The operation in the upper right half alone took an hour and a half. Calculus was not removed from that side at this time. Apoxesis and polishing of the left side were done in the conservative manner at a subsequent sitting. This required forty-five minutes. It took thirty-five minutes more, after healing of the surgical wounds, to remove the calculus and polish the teeth on the right side. Thus, only ten more minutes was spent for the removal of the deposits on the side untouched by surgical measures than was necessary for the surgically treated side with its easier access visually. A total of two hours and five minutes was spent in achieving a healthy condition by radical operation, which was similar to and certainly no better than that achieved by subgingival curettage in forty-five minutes. This would be justifiable if the results were very superior. In this case and all other cases that I have observed after radical procedures, the patient complained of severe pain and discomfort. This is generally recognized; hence, the detailed instructions usually issued to patients for after-care. The patient lost considerable time from work and other activities. The tissues healed with a scar formed by connective tissue. The blood supply of scar tissue is nil; hence, the nourishment of the gingival border is poor, and it becomes increasingly difficult to prevent recurrence of the disease. The esthetic appearance of the operated side is very poor. There is an obvious band of scar tissue tightly binding each tooth well below the cemento-enamel junction toward the root. The side treated by subgingival curettage has an even gingiva of smooth appearance, coming to a knife-like edge and embracing each tooth.

The financial aspect of the treatment is frequently mentioned. It is certainly erroneous to suppose that the surgical treatment is less expensive to the patient than the conservative. It is a well-known fact that, in this country at least, surgical operations of any kind command an extraordinary fee in proportion to the time involved in the operation. The more pain and discomfort a patient suffers, the more he realizes that he has had an operation and must pay for it. The actual time of operation is longer than in subgingival curettage, and hence the whole procedure is much more expensive. One cannot but think that at times an operator's love of the dramatic influences him toward radical measures rather than a less spectacular persistent effort.

The statement that radical surgical procedures are a short cut for the general practitioner is surely placing the cart before the horse. It is well known that, in general surgery, the young physician is trained first to know every aspect of the disease for which he intends to operate. He is then carefully trained in every step, so that he knows the textures of the various tissues that he must handle, their structure and their reactions. There is no short cut: he must learn by painstaking effort over a period of years. The same condition should certainly apply to the dentist who anticipates performing surgical operations of any kind in the oral cavity. The only dentist who is qualified to treat periodontal lesions of the oral mucosa surgically is the one who has spent many years practicing the conservative method and practicing it successfully. He can then judge texture, tissue reaction and other factors, and can decide whether the surgical method is indicated and where. He is also in a position to choose. There is no short cut for the general practitioner. To do anything successfully, he must cultivate the art of diagnosis, the visual sense, the

technic, thus developing skill and precision.

SUMMARY

Marginal gingivitis and vertical periodontoclasia have a similar etiology. They are caused by the presence of calculus, faulty dental restorations, bacterial invasion, occlusal stress and systemic conditions, such as nutritional and metabolic defects and metallic poisoning. Diffuse alveolar atrophy has a more obscure etiology, probably systemic. All three conditions are treated locally after careful consideration of all the local causes. After eliminating all the factors but the calculus, the technic of its removal is considered.

Subgingival curettage is the method of choice in marginal gingivitis because of the shallowness of the pockets.

In periodontoclasia and in diffuse alveolar atrophy extending into the gingival crevice, either subgingival curettage or surgical elimination of the pocket may be used.

In general, subgingival curettage is the method of choice because it causes no destruction of the tissue; it prepares the field for regeneration of the alveolar bone and readherence of the gingival tissue to the cementum; it causes a minimum of discomfort to the patient and does not incapacitate him for any time; and it carries no great element of shock. It has the disadvantages of operating by the sense of touch only, in an invisible field.

Radical surgical procedures may be indicated as a last resort when so much destruction of alveolar support has occurred as to render questionable retention of the teeth.

Patients on whom a surgical operation is to be performed have to have preoperative preparation of the field, requiring one or more visits and, after operation, are confined to bed for varying periods. Hence, surgical measures require much more of the patient's time as well as the dentist's than does subgingival curettage. The follow-up prophylactic care is just as requisite, and much more difficult after surgical operation than after subgingival curettage. The only advantage of surgical procedure is the fact that the field of operation is visible. An experienced operator in periodontal disease is the only person qualified to decide on the method best suited to individual cases.

## RETENTION AND STABILITY FOR FULL DENTURES*

By WILFRID H. TERRELL, D.D.S., Pasadena, Calif.

A GOOD impression method should be precise, should be productive of accurate and satisfactory results and should allow a minimum chance for error. It is essential that special trays be constructed that confine the impression materials to the required areas, prevent warpage and distortion of the materials, allow for compression or relief of the various areas and make possible the functional molding of the border tissues, giving maximum retention and preventing soreness from overextensions.

*Read before the Section on Full Denture Prosthesis at the Seventy-Seventh Annual Session of the American Dental Association, New Orleans, La., Nov. 6, 1935.

THE PRIMARY UPPER IMPRESSION

A tray that is sufficiently oversize is selected. White modeling compound is preferable for the primary impressions to transfer certain anatomic landmarks from the mouth to the impressions. This compound requires kneading longer than other compounds in order to secure a uniform texture. It is important that some form of electric compound heater be used to secure uniform working conditions of the material.

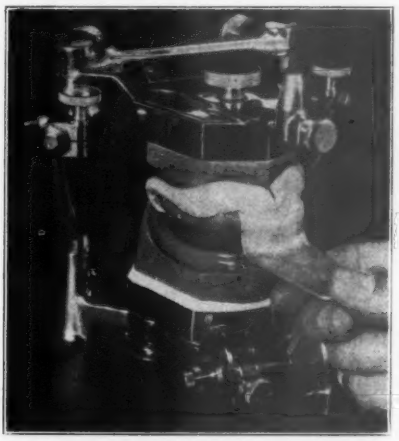

Fig. 1.—Seating upper primary impression.

Fig. 2.—Skull showing hamular notch.

The tray is filled with this softened material, which is molded high in the center of the vault and pressed down to approximate the form of the ridges. After slight cooling of the body of the material so that it possesses some resistance to pressure, the surface is glazed with a spot heating torch, and it is dipped in warm water and pressed firmly to place (Fig. 1), molding the muscles around the periphery. It is then chilled and removed.

Fig. 3.—Line marking distal aspect of upper denture.

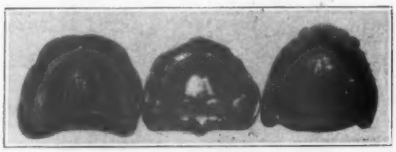

Fig. 4.—Different forms of distal borders of upper dentures.

Again, the surface of the impression is lightly glazed with the torch and it is reseated, the pressure being held upward and backward as it is chilled. This allows the harder incompressible points and areas to press deeper, and thus the load is distributed more comfortably over the

tissues. The impression is then thoroughly chilled and removed.

LOCATION AND TRANSFER OF ANATOMIC LANDMARKS FROM MOUTH TO IMPRESSION

With a mouth mirror (Fig. 2) the hamular notch is located, the mirror being moved distally along the ridge beyond the tuberosity to the point where it drops into the notch. It is important that this be very accurately located. If the denture is extended beyond this point, it will always cause soreness, requiring relief and a possible breaking of the seal. If it is ended short of the notch, the distal border will rest on hard tissue, and no permanent seal can be secured on this type of tissue. It must be placed on the flexible soft tissue, which is compressible.

Fig. 5.—Outline of relief and postdam area.

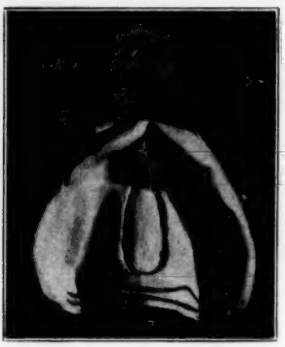

Fig. 6.—Upper primary impression prepared for pouring.

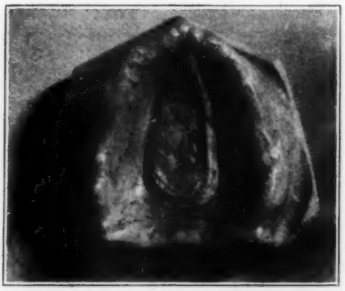

Fig. 7.—Upper cast showing relief and postdam areas ready for construction of upper impression tray.

Fig. 8.—Seating lower primary impression.

The tissues are dried with a cotton roll to remove any mucous film and, with a sharp, soft indelible pencil (Fig. 3), which is first dipped in water, a line is drawn exactly below the notch on each

side. Next, the palatal foveae, those two little pits in the center of the vault, usually near the juncture of the hard and soft palate, are located. A mark is made here and the patient is instructed to say "ah" several times, the operator noting whether the tissues of the soft palate are movable for any distance distad from this point. If so, a line is drawn where the movable curtain is hinged to the compressible, immovable soft palate and connected with the marks that locate the hamular notches, its direction being determined by the action of the movable soft palate.

Fig. 9.—Compound cut to uncover lateral throat form areas.

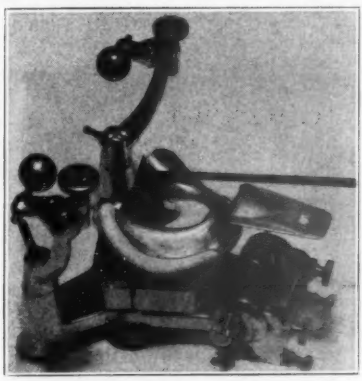

Fig. 10.—Area to which is added black compound.

The distal border of a correctly made upper denture may be straight, concave, convex or the shape of either the inner or outer surface of a brace. (Fig. 4.)

Next, with a ball burnisher, the width and depth of the compressible tissue in the postdam area are determined and the anterior boundary of the postdam is outlined with indelible pencil. The center of the vault (Fig. 5) is examined in order to locate a prominent bony area known as the torus palatinus, as well as any hard area in the central portion of the vault that may be covered by thin tissue. This area is outlined, being extended anteriorly to include the incisive

Fig. 11.—Placing pressure in lateral throat form areas.

Fig. 12.—Completed lower primary impression.

foramen and the large central rugae prominence, which is so easily irritated by pressure. If the rugae are prominent and movable, the entire area is outlined. It is undesirable to place the rugae under compression for two reasons: (1) they are usually distorted and easily irritated, and (2) the tendency of an upper denture in settling is always to move upward and forward, placing excessive pressure in this area and causing much discomfort and often tissue changes.

Fig. 13.—Lower cast prepared for construction of lower impression tray.

Fig. 14.—Two lower dentures for same mouth. The one at the left has retention and stability.

Moisture is removed from the inner surface of the upper impression and it is seated firmly in place and held long enough for the transfer of these marks. It is then removed and the lines are filled in where they may have failed to make a perfect transfer. With a sharp knife or a chisel shaped vulcanite scraper, from one-sixteenth to one-eighth inch of compound is removed within the boundaries of the lines, the hard areas and the rugae being marked. With a sharp instrument or scaler point, a groove is made in the compound along the line that marks the distal extremity of the upper denture; also along the other line anterior to that which denotes the anterior boundary of the postdam area. This area (Fig. 6) is usually narrow distad from the tuberosities, rather wide as it extends toward the center of the vault and usually again narrow at the center. The upper impression is now ready to be poured in one of the quick-setting stones. The grooved lines along the postdam will

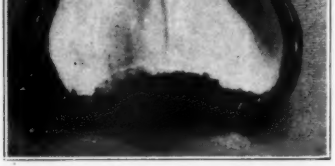

Fig. 15.—Upper tray with compound added on periphery ready for muscle trimming and postdamming.

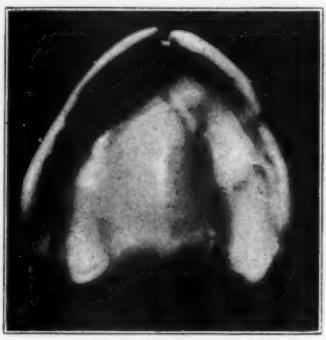

Fig. 16.—Upper impression prepared for final insertion.

be transferred as embossed lines to the cast (Fig. 7), giving the exact location of the distal border of the denture and the width of the postdam.

The cast that results from this primary impression is the one on which the special, individually designed impression tray, for the upper impression, is to be made. It is impossible with a stock tray filled with plaster, compound, dentocoll

Fig. 17.—Lower tray with compound added on periphery ready for muscle trimming.

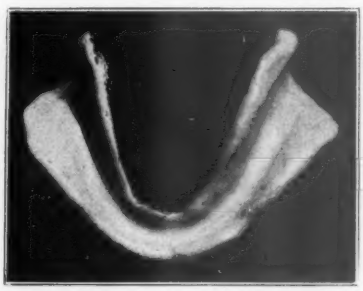

Fig. 18.—Lower impression prepared for final insertion.

or any of the many impression materials available, to secure accurately an impression which places varied pressures where required, relieves where required and secures functional molding of the peripheral borders and postdam areas. These can be done arbitrarily and are so done by those who use these methods, but they lack the accuracy and perfection that are required.

THE PRIMARY LOWER IMPRESSION

A tray that is oversize is selected for the lower and the buccal and distal edges are bent outward and upward so that it may be pressed against the tissues without causing injury. The areas to be covered are determined carefully as the lower impression is far more difficult than the upper. The lower denture area is studied and classified. Whether the lateral throat form areas may be utilized for

Fig. 19.—Two upper dentures for same mouth, demonstrating principle of extension for retention and stability.

Fig. 20.—Two lower dentures made for one mouth with no anterior ridge. The one on the right has retention and stability.

retention and whether lingual extensions will be an aid is then determined. If there are no lateral throat form areas when the tongue is protruded as far as is necessary for moistening the lips, it is a waste of time to try to secure an impression of these, for flanges are not indicated and cannot be tolerated without irritation. Likewise, if the attachment of the under surface of the tongue to the floor of the mouth is broad, and extends

laterally nearly to the mylohyoid ridge on either side when the tongue is raised to the vault, this area cannot be utilized. Often, farther anterior in the floor of the mouth distad from the sublingual glands between the under surface of the tongue and the floor of the mouth, there is a flat area that is not disturbed by elevation of the tongue. It may sometimes

Fig. 21.—Two upper dentures for same mouth. The one with peripheral adaptation has the best retention.

Fig. 22.—Edentulous models mounted ready for setting up teeth.

be utilized for an extension on which the tongue may rest and aid in stabilizing the lower impression. Any or all of these measures should be carried out when possible as they are a mechanical aid to retention, and the extension of the borders lingually as well as buccally materially aids in forming a seal that, in many instances, is comparable to that secured in the upper impression. A small, narrow, lower denture is a failure from a

Fig. 23.—Anterior view of teeth set up in wax.

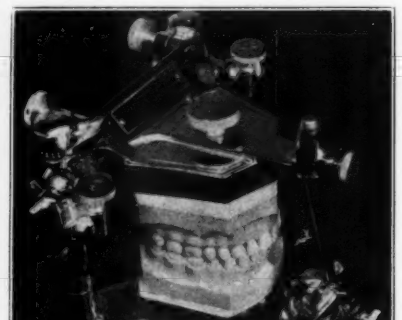

Fig. 24.—Lateral view with teeth balanced.

retention standpoint as well as insufficient in the distribution of the load to an area that is already much too small. If

the impression is to include any of these areas in the floor of the mouth, the lingual flange must be bent and flattened out toward the tongue in that particular area. If impressions of the throat form areas are to be taken, the distal end of the lingual flanges of the tray are cut off at a 45 degree angle. This will uncover these areas, making it possible to mold compound laterally by finger pressure after the remainder of the impression has been taken.

Sufficient white compound is softened and kneaded, seared to the tray and molded to approximate form. It is allowed to cool slightly, the surface is glazed, the compound is dipped in warm water and the tray is centered and held with firm steady pressure as it is seated, (Fig. 8), the operator instructing the patient to raise the tongue, protrude it and move it from side to side. The impression is cooled, removed and thoroughly chilled. There should be an excess amount of compound particularly toward the buccal aspect so that it will show definitely the outline of the external oblique line. It is desirable to utilize as much of the area as possible between the crest of the ridge and this boundary for stress-bearing in the molar region. If an impression is to be taken of the throat form areas, the compound is cut to a sharp line (Fig. 9) along the edge of the tray on the distal aspect of the lingual flanges where it has been cut away to allow for the impression (Fig. 10). A piece of black compound the size of an olive is heated and seared to the white compound along the line just trimmed. It is then molded to approximate form and the surface glazed and it is replaced in the mouth, being held with very firm pressure (Fig. 11) while the index finger places pressure laterally on the extension of the black compound.

The black compound hardens more quickly than the white and, being slightly harder, breaks away from it easily when this is required. Also, the contrasting color (Fig. 12) shows where it may have overlapped. When the impression is cool, it is removed and the extension fractured along the line where it was originally joined. This is necessary in order to secure the impression of the opposite side; for, in most cases, there is sufficient undercut to make it impossible to remove a lower impression with both of the extensions intact. When it has been fractured, it can be readily replaced in the exact position and reattached with sticky wax before the model is poured. The impression is taken in the same way on the opposite side with the exception that the extension is not removed. The first extension is reattached and the impression is ready to be poured in one of the quick setting stones. It is on this cast (Fig. 13) that we will design the impression tray that is to cover the areas necessary to withstand the stresses of mastication and also those areas that must be utilized in order to secure successful retention for the full lower denture. A well-formed ridge is the ideal, but a mouth that is flat and has no ridge is not hopeless, and successful cases can be built if attention and thought is given to the details of making the lower impression.

Just recently, I constructed a set of dentures for a patient (Fig. 14) with a mouth of this type who had previously had fourteen sets of dentures and none of them satisfactory. She had had some previous lower dentures in which an attempt had been made to place lateral throat form extensions and, in each case, they had had to be removed because of the irritation. She has had no irritation whatsoever in the lateral throat form areas with the new denture, and it is impossible to remove the lower denture without first pushing it upward and

backward. This, together with the peripheral seal, gives her the retention for the lower denture that she has never had in any previous dentures.

### PREPARATION OF UPPER CAST FOR VULCANIZATION OF THE TRAY

With a No. 10 round bur, the cast is grooved across the postdam area to one half the depth of compressibility of the tissue. This will automatically seal this area and yet allow for functional molding of the border to perfect this seal. The nonstress-bearing areas were relieved in the impression and now appear as raised areas on the cast. The tray when vulcanized should have very good retention and should be comfortable under heavy pressure.

### CONSTRUCTION OF VULCANITE TRAYS

One and one half to two thicknesses of baseplate wax should be adapted to the casts. All borders should be sufficiently thick to serve as a support for molding the compound that will be used in muscle trimming, and there should never be any thin sharp edges. The tray should be very rigid to prevent distortion. A small piece of wax is placed on top of the front of each tray to serve as a handle when vulcanized.

Before making the final impressions, both trays should be carefully checked in the mouth for overextensions. This is very important and should be very carefully done. Tissue distortion by the tray prevents securing a good impression and results in soreness later. The form of the tray in the lateral throat form areas should be the arc of a circle and not irregular, for these tissues are quite flexible and do not have a definite form of their own, but function as a unit over the border of the denture. Overextensions of the tray in this area must be guarded against.

### MUSCLE TRIMMING, POSTDAMMING AND PERFECTING THE UPPER IMPRESSION

Green stick compound (Fig. 15) is traced around the entire peripheral border of the upper impression tray and also across the postdam. With a spot heating torch, the surface is glazed uniformly, and the compound is dipped in warm water. When in the moldable stage, it is seated firmly. The borders are molded lightly from the outside while held firmly in position with the index finger. The patient is asked to make the lips tense, place the tongue against the roof of the mouth, suck and swallow several times. This action will mold all the borders, including the postdam if the consistency of the compound has been correct. The compound is chilled thoroughly before removal. The excess compound that is molded down on the outside of the tray should be trimmed off in a line parallel to and approximately one-quarter inch from the border. The borders are reheated in sections after the same muscle trimming procedure, until no excess compound is molded below the straight line that had been cut parallel with the peripheral edge. A test is made for tendencies to dislodgment by applying pressure outward on the ridges in every direction, and if the seal is not perfect at this time, it should be corrected by tracing a little more compound on the point where air bubbles may be observed. When it withstands all tests for retention, it is ready for a perfecting material that will copy the finest surface detail and will flow with sufficient ease to prevent pressure on the nonstress-bearing areas. (Fig. 16.) The material used for this is one of the zinc oxide impression pastes, such as "cooralite" impression material or one of the correcting materials, such as "indicator jel," which softens with low heat. They record fine tissue detail and do not adhere to the soft tissues. The difficulty

with the use of plaster and most other similar materials mixed with water is that they fracture easily and have a tendency to adhere to the tissues.

Before the material used for completing the impression is placed in the tray, it is well to drill a hole through the highest point in the vault of the tray. This will aid materially in breaking the seal when removing, so that force will not be required. Compressed air and water may be injected through this opening; which will greatly facilitate the removal of the impression. The impression is coated with a layer of the material selected for the final perfecting and the tray carefully seated. The patient is asked to close the lips firmly, suck and swallow as before. If desired, the upper and lower impressions can both be taken under biting stress by attaching a center bearing appliance, such as Stansbery checkbite plates. Good results may be obtained either way.

The impression should be poured immediately after and the peripheral border preserved exactly as molded. This impression gives us the application of stress where it can best be borne, relief of non-stress-bearing areas, the finest tissue detail and a very accurate peripheral seal.

### MUSCLE TRIMMING, SECURING RETENTION AND PERFECTING THE LOWER IMPRESSION

A greenstick compound (Fig. 17) is traced quite heavily along the borders of the lower tray, with the exception of the throat form flanges, softened uniformly with the torch, dipped in warm water and seated firmly. If sufficient compound is applied, it will flow upward toward the crest of the ridge and join in the center. The buccal and labial borders are muscle trimmed in sections. The excess compound is trimmed parallel with the border of the impression as with the upper, until no excess is left below this line. If extensions cover certain areas of the floor of the mouth, care should be taken not to displace the tissues downward. The tongue molds the lingual borders by function, the tray being trimmed if necessary until the tongue is not limited in its functional range. Lastly, compound is traced on the throat form flanges, one at a time, and the impression seated firmly. The patient is asked to protrude the tongue and move it from side to side, then close and swallow; then apply pressure with the tip of the tongue against the lingual aspect of the anterior portion of the tray, thus causing the tongue to expand laterally. When the impression is completed, it should have not only suction, but also mechanical retention, in many instances. The impression is then coated with the same material (Fig. 18) that was used for completing the upper impression. Biting stress may be applied by means of the center bearing if so desired.

Stability, comfort and permanency of result are the ideals toward which the operator should work. There is a great deal of controversy as to whether impressions should be taken under biting stress or under manual pressure. From a theoretical standpoint, impressions taken under biting stress should be superior, as the actual muscle forces are active in seating the impressions. From a study of practical results, there is no advantage to be gained as the operator actually has more control over the pressure applied and the direction of force by the manual method than under biting stress. We have taken a great many impressions both ways in an attempt to determine the better method. We have never favored any short cuts if there is any loss of accuracy whatever; but we are not in favor of complicating or lengthening a technic just to meet theoretical arguments unless the end-results can be proved superior.

SUMMARY

1. Impressions are taken with especially constructed vulcanite trays that fit practically as well as the finished dentures with the exception of the peripheral adaptation, relief and correction of the nonstress-bearing areas and extension for retention.

2. The bases being rigid, completion of the impressions can in no way distort or change the result thus far obtained.

3. Muscle trimming and postdamming can be much more accurately done on a rigid, accurate base.

4. There is a definite length for the upper denture based on the anatomic structure of the maxilla and the function of the muscles of the soft palate.

5. There is a definite width and depth of the postdam, which is determined by the character of the tissues in the various areas and then functionally molded by the tissues themselves.

6. The relief of the nonstress-bearing areas is in proportion to the compressibility of the ridges.

7. The lower has extension for retention and usually has both mechanical retention and a peripheral seal.

8. The stresses are distributed over all the available stress-bearing areas of both the upper and the lower impression; which increases the ability of the ridges to withstand stress.

9. If each step of the impressions is carried out accurately, we will have an upper and lower impression in each full denture case that embodies the maximum retention against displacement forces and a maximum stability under stress of mastication.

10. Time spent in securing accurate impressions will prevent remakes and the operator also has the satisfaction of knowing that he has given the patient the best possible retention and stability in the foundation of the dentures that he is constructing.

# SOMETHING NEW IN CUSPS AND SULCI ANALYSIS, BALANCED AND FUNCTIONAL OCCLUSION AND STRESS-BREAKERS*

By F. S. MEYER, D.D.S., Minneapolis, Minn.

## CUSPS AND SULCI ANALYSIS

THE subject of cusps and sulci analysis is, as far as I know, new in dentistry. While we have been in the habit of leveling the elongated cusps to an approximate curve before proceeding with restorations, how much we should cut or lengthen the cusps has always been a matter of personal preference. No scientific method of arriving at conclusions was employed. A little later on in this paper, I shall give a scientific and accurate method for determining how much to lengthen or shorten the cusps, and how much to deepen or fill in the sulci of the opposing teeth in order to be sure of balanced and functional occlusion when the restorative work is

*Read before the Section on Partial Denture Prosthesis at the Seventy-Seventh Annual Session of the American Dental Association, New Orleans, La., Nov. 6, 1935.

completed. Guesswork is entirely eliminated.

### BALANCED AND FUNCTIONAL OCCLUSION

Before entering on the discussion of balanced and functional occlusion, let us have some understanding of what is meant by the term. The dictionary gives the meaning of the term occlusion as the closing or the transient approximation of the edges of a natural opening. The occlusion of the teeth is, therefore, the closing of the teeth or the bringing together of the occlusal and incisal edges or surfaces of the teeth. It follows, then, that the most accurate occlusion is that wherein the greatest number of surfaces or cusps are brought together at one time.

It is possible to bring the teeth together at one time by exerting greater pressure at one point than at another, even though all the teeth do not touch at the same time when the jaws are brought together lightly. We have then an occlusion, but it is not a balanced occlusion.

### BALANCED OCCLUSION

A balanced occlusion is one in which the teeth touch with equal pressure at three or more points of a triangle laid out on the occlusal surfaces of the teeth. This is spoken of as a three-point balance; but the most accurate balanced occlusion is one wherein all the opposing surfaces or cusps touch with equal pressure at the same time. It is possible to have accurate balanced occlusion in centric relation and still have the teeth far from balance or far from occlusion in the lateral excursions of the mandible. Unfortunately, that is too often true in dental restorative work; and if it were not for the resiliency of the tissues of the mouth, most of our dentures of the past would probably have been dismal failures, or, perhaps I might say, most of the dentures as built today would be dismal failures.

### FUNCTIONAL OCCLUSION

Functional occlusion is that meeting of the upper and lower teeth which permits them to grind or crush the food. When the teeth are locked by interfering cusps, they can still function in centric relation; that is, in an up-and-down movement only. In fact, certain persons seem to get along quite well in their mastication when the teeth are locked in occlusion. We usually think of functional occlusion as that occlusion which permits the teeth to function without any interfering cusps in the lateral as well as the protrusive excursions of the mandible; and balanced and functional occlusion as that which permits the teeth to balance while functioning during all the excursions of the mandible.

### SINGLE CURVE

The most accurate balanced and functional occlusion can be obtained only when all the cusps touch an arc approaching that of a sphere, or, in other words, a single curve. In such a case, the overjet must be less than half the width of a bicuspid tooth. For esthetic reasons, with a single curve and an extreme overjet, the cusps must be long enough to allow a closure in centric occlusion concealing the opening between the upper and lower anterior teeth. In our restorative work, cusps of such extreme length are not practical. In such a case, we must resort to a compound curve, as has been described.[1]

The shorter the cusps are, the less overjet is permissible without showing a space between the upper and lower teeth in centric relation. It follows that, with

1. Meyer, F. S.: Balanced and Functional Occlusion in Relation to Denture Work, J.A.D.A., 22:1156 (July) 1935.

flattened cusps, there can be no overjet without showing a space between the upper and the lower anterior teeth. We will then have an end-to-end bite. This will permit the most accurate balance with absolutely the least lateral stress in the act of mastication.

### COMPOUND CURVE

When esthetic values demand an overjet greater than half the width of a bicuspid tooth, a compound curve is necessary in order to have balance in all the excursions of the mandible. In such a case, only a three-point balance is possible. In order to avoid too high cusps, with a considerable overjet, it is always advisable to build to a compound curve. In many cases, this increases the esthetic values. The greater the overjet, the more pronounced the compound curve.

### STRESS-BREAKERS

While the subject of stress-breakers is not new, comparatively few dentists know anything about them. I shall take this up later in my paper, introducing three types that I believe are new to the profession. Two of them never have been used before and one only in a modified form.

In my last three papers read before the American Dental Association, I discussed balanced and functional occlusion in cast bridgework as well as in full upper and lower dentures built on plane line articulators. Today, I shall discuss partial dentures.

The technic, as now used, for setting up and grinding in teeth for partial dentures can hardly be called a technic. It is a conglomeration of personal equation, judgment and guesswork, without a single scientific step to guide us. But with this technic, which is based on scientific principles, I hope to present something that will help the dentist to build a more comfortable denture than ever before.

As the technic is the same for practically all partial dentures, I shall choose for the purpose of discussion a lower lingual bar denture. Let us assume that this lingual bar denture, supplying the bicuspids and molars, is to be built to function and balance with whatever teeth happen to be above.

A great deal might be said about impression taking, but that is out of the sphere of this paper. We shall start with a good stone model of the lower arch.

Two accurate baseplates are formed in a material that will not become distorted at mouth temperature, one of these being built up with a rim of hard black compound to the vertical dimensions desired. Black compound is used because it can easily be seen through a thin layer of pink wax. It is best to form the compound bite-rim on the wet cast before tacking it on the baseplate. If we place too great a bulk of hot compound against a baseplate, we are liable to distort it. This trial plate is contoured for facial expression so that we may be sure of correct vertical dimensions. We must be sure to check the baseplate for accurate seating before the compound is tacked on. If, after the compound has cooled, it is found that the baseplate rocks, hot water is run over the under side and it is quickly forced to place on the cast. This will stabilize it again.

The compound is built well up against the anterior teeth so that it rests as steadily as possible. The compound surface lying against the anterior teeth is resoftened and the compound trial denture quickly inserted in the patient's mouth. Transfer must be made from mouth to cast and back again without rocking. The compound occlusal surface is then resoftened while the trial plate is on the cast and the plate is quickly in-

serted in place in the mouth. If the compound is softened while the trial denture is not on the cast, a distortion of the baseplate may follow. The patient is asked to place the tongue against the roof of the mouth and close the teeth. When the compound is cooled to mouth temperature, it is removed and cut away down to the level of the cusp indentations from the upper teeth, only the ridges of compound that fit up into the sulci and interproximal spaces of the upper teeth remaining. It is replaced in the mouth and the patient is asked to close in rest position. The chances are that the teeth will slip to one side or the other. When one closes into a large amount of compound, it is difficult to close correctly. A little soft compound is traced along the occlusal aspect, and resoftened and the patient is asked to repeat the closing as before. This time, he is more likely to close correctly, because there is not a large amount of compound to force the mandible out of rest position. The compound is trimmed away as before and checked for centric occlusion. If the patient can consecutively open and close in centric occlusion with the teeth fitting into the same indentations in the compound, we are ready to analyze the opposing cusps and sulci.

It is here that we meet one of the most fascinating subjects in dentistry. Here, we discard the guesswork of the past and adopt a technic of scientific accuracy; for, with this technic, it becomes possible to know before a single tooth is inserted in the trial denture what can be accomplished by way of balance and function when the denture is completed.

When the patient has closed into the compound at the correct bite opening and the compound has been trimmed away as before described, the compound bite-rim is widened 3 or 4 mm. at the level of the cusp indentations. The compound is replaced in the mouth and the patient is asked to make the right lateral excursion until the compound ridge below is opposite to or touches the buccal cusps above on the right side. He is asked to hold his teeth in that position. If the compound ridges below do not touch the upper buccal cusps, it is here that we find out why, making the necessary corrections to bring them into contact. If none of the compound ridges touches, we look to the opposite side for too long lingual cusps on the upper teeth; or it may be that the sulci of the upper left teeth are too deep or the compound ridges extending into the interproximating spaces may interfere. The latter are eliminated by trimming off the compound ridges if they interfere. If there is still no contact on the right side in the right lateral excursion, the patient is asked to make the left lateral excursion. If there is then contact on both sides, the lingual cusp of the left upper tooth, interfering in the right lateral excursion, is too long by the amount that the teeth on the right side are held apart. The interfering lingual cusp or cusps are trimmed off until there is contact on both sides. But if there is contact only on the left side in the left lateral excursion, both the lingual and the buccal cusps of the interfering tooth are too long by the amount that the right side is kept apart in the right and left lateral excursions, respectively. That is equivalent to saying that the sulci of the left upper interfering teeth are too deep. If the amount of separation on the right side in the right and left lateral excursion is only slight and may be due to the presence of a sharp ridge of compound extending into a deep fissure in the upper interfering tooth or teeth, this compound ridge may be sheared off by having the patient make a few lateral excursions with the teeth and compound in contact.

If it is a very noticeable amount, the cusps must be trimmed off or the sulci must be filled in. Otherwise, there will be no contact in centric occlusion when the case is finished.

If, in the right lateral excursion, the upper right molars alone maintain contact with the compound ridge below, the buccal cusps are too long in proportion to the buccal cusps of the bicuspids or the sulci are too deep in proportion to those of the bicuspids. To correction of this condition, there are several methods of approach. If the sulci in the bicuspids are deepened, the length of the opposing compound ridge is increased and thus contact is restored in the right lateral excursion; but, in deepening the sulci, we may increase the overbite as we may increase the vertical dimensions in the act of protrusion. If we wish to increase the overbite, we may do so by deepening the sulci; but, even if we do this, we may still have to trim off the buccal cusps of both the molars and the bicuspids in order to obtain contact on the opposite side in the right lateral excursion. Otherwise, we might be compelled to deepen the sulci on the opposite side. Trimming off the buccal cusps may also tend to diminish the overbite and thus defeat our purpose. If we do not wish to increase the overbite, the buccal cusps of the molars or bicuspids, whichever happen to touch first in the right lateral excursion, may be trimmed off.

In this analysis, with corrections, we may approach perfection indefinitely according to the efforts expended. We have decided that we need to trim off a certain amount from the buccal cusps. But at what angle must this trimming be done? What will be the angle of the inclined plane when we get through trimming? We shear off the interfering compound ridge by having the patient go through the lateral excursions, then trim the interfering cusp from the sulcus outward to a plane or facet parallel to that of the sheared compound ridge; fill in some soft compound and ask the patient to close into it; trim the compound away from the sides, and try the lateral excursion again. We then find that the compound ridges will touch all along the buccal cusps.

If a molar or a bicuspid should have a crown with the sulcus obliterated and the occlusal surface flat while the other teeth have deep sulci, I do not hesitate to cut into the gold to deepen the sulcus even to cutting through the crown. If we should cut through the gold, the opening may be treated as a cavity and filled; but if we do not cut through when necessary and leave a flat occlusal surface, we will not obtain the utmost in balance and function.

The cusps and sulci on the left side are analyzed in a similar way. In fact, the two sides are usually carried through at the same time.

While we are checking and correcting for lateral excursions, we also check for protrusion. The patient is asked to make the protrusive movement as in the act of incising. If an upper bicuspid or molar tooth is elongated, as is often the case, it will interfere with the compound ridge directly back of it and below. If possible, the elongated tooth should be trimmed down to the level of the other teeth. If that is not possible or advisable, the interfering compound ridge will have to be sheared off in protrusion. In such a case, there will be an area equal in length to the amount of overjet that will be out of contact in centric occlusion and another area equal in length that will be out of contact in protrusion. Evidently, the utmost in function cannot be attained unless the elongated tooth is trimmed off to the level of the other teeth. If an upper molar or bicuspid is short, the

compound ridge meeting it in centric occlusion will interfere with the tooth anterior to it in protrusion. This tooth should be lengthened, if possible. If not, the compound ridge meeting it in centric occlusion should be sheared off. In that case, the occlusal surface of the tooth below the short upper tooth will not make contact with it in centric occlusion. It may make contact with an upper tooth in protrusion. Whether an upper tooth is too long or too short, no more compound in the opposing arch need be sheared off than the length of the overjet. Hence, the shorter the overjet, the less function is lost by an opposing tooth's being out of occlusal alinement with the other teeth. Some function is always lost in the lateral excursions if an opposing tooth is out of occlusal alinement.

If the case is built with a pronounced overbite, a tooth too long or too short in the bicuspid region may not interfere in protrusion because the opening of the bite in the act of incising or even during the act of protruding may separate the bicuspids enough to avoid interference. In such a case, a compound curve is called for if we wish to have balance in protrusion. The teeth out of occlusal alinement may call for some alterations in the lateral excursions. That is taken care of in the lateral excursion analysis.

If the upper teeth are natural teeth, contact in the molar region in protrusion is not necessary in a lower lingual bar denture. I try to obtain it if possible, for it may prove to be advantageous if the upper teeth should later on be lost. If the upper three molars are in place and there is a large overbite and overjet, it may not be advisable to seek balance in protrusion, especially if it calls for too much grinding. But if one or more of the upper molars are gone, contact in protrusion is more easily obtained and generally advisable.

In analyzing the situation, the compound extending up into the space beyond the last molar may be cut down or sheared off until it maintains contact with the upper molar during the whole act of protrusion. If the first upper molar is gone, the compound ridge extending up into the space left by the missing molar may be utilized to maintain contact in protrusion as well as during the act of protrusion. Sometimes, deepening a sulcus or a lateral groove may allow a ridge of compound high enough to maintain contact in protrusion if the overbite is not too great.

There is hardly a limit to the extent this analysis can be carried in seeking the utmost in balance and function for the finished case. It must be remembered that these compound ridges left when we are through the analysis will later on be replaced by the buccal cusps of the lower bicuspid and molar teeth. Hence, if we are able to obtain a balance in every position of the mandible with these compound ridges, we also will be able to get a balance with the buccal cusps of the bicuspids and molars in the lateral excursions. Moreover, we will also obtain balance on the functioning side with the lingual cusps as well, if the irregularity of the upper teeth is not too great. These compound ridges become the guiding factors in controlling vertical dimensions in the generation of the path to which all the occlusal surfaces of the lower teeth are, later on, to be ground.

When all the analyses and corrections have been made, a thin layer of compound is shaved off at the base of the compound ridges. This will allow the soft wax to conform to the opposing occlusal surfaces with the apices of the ridges controlling the vertical dimensions during the excursions of the mandible. With a hot spatula, a groove is cut on each side of the compound bite-rim. This

will serve as a finger grip in forcing the case to place and steadying it in the mouth, or on the cast, when the wax path has been generated.

We are now ready to generate the wax path. A few sheets of ordinary baseplate wax and an equal amount of soft pink carding wax are melted in a pan of boiling water. When cooled, this will form a sheet on the surface of the water and will be the right consistency for the generation of the path. It is allowed to flow over the compound bite-rim in a melted form. The occlusal surface is covered to the height or level of the compound ridge. It is not patted down with a hot spatula for this is liable to destroy the thin compound ridges. It is allowed to reach room temperature and is then placed in the mouth. The patient is asked to moisten his upper teeth with saliva and bite in centric occlusion, with the tongue touching the roof of the mouth, and make a slight excursion to the right and then to the left, followed each time by opening and closing again in centric occlusion. This is repeated, the patient being asked each time to moisten the teeth and make a longer excursion, until he goes a little beyond the natural range of occlusion. We have him slide the teeth into protrusion; again opening, and closing in centric occlusion. The compound is removed and examined for certain discrepancies. There may be a pulling away of some of the soft wax or some may be found sticking to the opposing teeth. The wax is dried and some more hot wax is allowed to flow in, filling up all the discrepancies. Then the patient is asked to moisten the upper teeth and repeat the excursions. This is repeated until there is a well-defined path in the wax. The apices of the compound ridges will show up plainly; and even over a considerable portion of the wax path, the black compound will show through.

The lower cast is mounted in a rigid plain line articulator meeting the requirements of the technic. The base for anchoring the cast on the upper part of the articulator is replaced with the extension in order to cut down the bulk of plaster. The greater the bulk of stone or plaster used in pouring the bite, the greater the liability of distortion of the path from the heat of the setting stone or plaster. Before pouring this bite, the saliva from the wax surface is thoroughly washed away. Soap suds is used, followed by cold water. If this is not done, the acid or whatnot in the saliva will cause the stone or plaster to crumble at that point, a serious defect resulting. This is very important and must not be overlooked. Before the bite is poured, the space between the two sides is filled in with a sheet of wax or any suitable material and the wax path sealed to the cast all along the margin. This will prevent the plaster or stone from flowing where it is not wanted. By means of the grooves cut in it, the compound on the sides of the wax path is forced to place on the cast. While it is held in place, it is tacked with hot wax. It must always rest steadily and securely. The lingual and labial aspects of the anterior stone teeth are covered with wax almost to the incisal aspect. This will prevent the stone model from adhering to the stone teeth when poured. The tips of the anterior teeth are covered with a little vaseline to prevent adherence of the stone. The articulator is adjusted on the sides so that the extension will not quite touch the wax path. A batch of stone is mixed and vibrated to place in the wax path, the operator helping it to flow to place by the use of a soft wet brush. The articulator extension is covered with some of the mix of stone, and closed. When the articulator has been opened, the incisal ends of the anterior teeth, as well as the adjust-

ment screws on the sides, will serve as stops to control vertical dimensions. The stone path will indicate the position of the upper teeth.

Before starting to grind in the lower teeth, I usually open the bite in front about 3 or 4 mm. by screwing in one of the set screws. If the opposing teeth, and hence the stone path, is very regular, the opening need not be so large, for there will be less grinding needed in perfecting the occlusion. In first setting up the teeth, I do only approximate grinding to the stone path. At this stage, one can judge the amount of bite closing that will be required in perfecting the occlusion by the distance from the stone path to some part of the occlusal aspect of the molar or bicuspid not touching.

Before starting the final grinding of the teeth to the stone path, the path is covered with a film of Prussian blue. This may be cut in either water or oil. Oil remains soft the longest and works the best, but it is more difficult to clean away when the case is finished. When cut in water, it is easy to clean from your hands. In either case, I keep a roll of cotton soaked in oil or water to keep the surface continually soft or moist when spot grinding. By continually opening and closing the articulator, it is easy to see where to grind by the spots on the porcelain teeth marked with Prussian blue. The closer we grind in the porcelain teeth to the stone path, the better the balance and function in all the excursions of the mandible. If, when the case is nearly ground in, we find that the articulator is opened too much, the wax is softened a trifle by heating the teeth over a flame, and gently closed. The grinding is then finished. It is well to leave the bite open a trifle to allow for settling. Theoretically, that calls for a greater amount of settling in the anterior region than in the posterior in order to maintain balance. Whether we get that, I do not know; but, practically, it works. When the teeth have been ground accurately to the path, surface to surface, the most accurate balance and function are assured when the denture is slipped to place in the mouth. No adjustment of the teeth in the mouth will be necessary except for esthetic values, and then the denture must be returned to the plain line articulator for final checking of the occlusal or incisal aspect.

About the subject of stress-breakers, little is said or done in general practice. The double lingual bar is practically the only stress-breaker in general use. And that is of little or no value when the clasped teeth are separated by four, or fewer, teeth. When the clasps are anchored to the first bicuspids, the double bar serves as a very efficient stress-breaker. When the lingual bar denture is anchored to five or six lower anterior teeth, I use a triple bar stress-breaker. A bar of No. 14 clasp gold, anchored to one clasp, extends over to just beneath the other clasp. Then another bar of the same size is anchored to the other clasp and passes down by the end of the first bar, to which it is soldered, and on to just below the first clasp, where it is anchored to the lingual bar. This makes a very efficient stress-breaker when the anchor teeth are quite close together. There may be very resilient tissue under a denture anchored with such a stress-breaker and still be no material stress on the anchor teeth.

Another stress-breaker is used for individual molars, either upper or lower. Firmly gripping a lone molar with a clasp and a rigid rest lug in most cases shortens the life of that tooth. Often, we are better off with the rest lug cut off altogether. In such a case, the denture is driven against the tissues and held there by the clasp. That also is detrimental to

the life of the tooth and surrounding tissues. This individual molar stress-breaker is a very simple device. It serves a double purpose of both clasp and stress-breaker. With this clasp, the rest lug is placed in the distolingual groove of the upper molar or the lingual groove of a lower molar. The clasp then passes around the distal, buccal and mesial aspect of the tooth with an extension toward the rest lug, and a little clearance on the buccal aspect. From the mesiolingual aspect of the clasp, there is an extension to a strengthener or gold base, depending on what the case is constructed of.

The last of these stress-breakers of which I wish to speak is one that we have used on upper cuspids, consisting of a clasp with a rest lug and a clasp gold bar extending distally from the clasp just to the lingual aspect of the upper posterior teeth. This bar is embedded in the vulcanite, or gold, or in whatever material the denture is constructed of.

The trouble with a great many stress-breakers of the past is that they have not had enough resiliency or flexibility, nor have they been properly heat-treated to prevent breaking.

With the stress-breakers that I have just described, we have not only enough resiliency or flexibility, but also sufficient stability for support. In the act of mastication, the denture is forced against the tissues without any apparent stress on the supporting teeth. When the pressure on the teeth has been relieved on separation of the upper and lower teeth, the stress-breakers automatically allow the denture to reassume its rest position in relation to the tissues. This consecutive pressure, followed by relaxation, massages the gum tissues and should tend to keep them in a healthier condition.

Many of the statements that I have made in this paper are new to the profession and they cannot be followed without study.

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# RELATION OF RESPIRATION TO MALOCCLUSION*

By LELAND R. JOHNSON, M.S.D., D.D.S., Chicago, Ill.

AS an introduction to this paper, may I quote Howell,[1] who says,

It is one of the generalizations of physiology that all living things, with the exception perhaps of the anaerobic organisms, require oxygen for their vital processes—that is, for the normal course of those chemical changes in the tissue cells which we group under the general term of metabolism. On the other hand, one of the universal end products of this metabolism is carbon dioxid. Hence, respiration in some form is one great characteristic of living things. In the simplest animals and plants, the unicellular organisms, the exchange between air (or water) and the organism takes place directly, but in the more complex animals some form of respiratory apparatus is developed whose function consists either in bringing the air or oxygen-laden water to the constituent cells, as in the air tubes of the insects, or in bringing the circulating

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1. Howell, W. H.: Textbook on Physiology, Ed. 11, Philadelphia: W. B. Saunders Co., 1931.

blood into contact with the air or water, as in the case of animals provided with lungs or gills. In man and the air breathing vertebrates the latter device is employed and one may distinguish in such animals between internal and external respiration. By the latter term is meant the gaseous exchange, absorption of oxygen and elimination of carbon dioxid, that takes place in the lungs between the blood in the pulmonary capillaries and the air in the alveoli. By internal respiration is meant the similar exchange that takes place in the systemic capillaries between the blood and the tissue elements.

The thorax is a cavity completely shut off from the outside and from the abdomen. The lungs in their collapsed state are smaller than the thorax. The

Fig. 1.—Typical appearance of child having adenoids developed to degree necessitating mouth breathing. (After McCoy, J. C.: Applied Orthodontia, Ed. 3, 1931.)

atmospheric pressure on the interior of the lungs expand these structures until they fill all the space in the thorax not occupied by other organs. An increase in the size of the thorax by lowering the diaphragm or by elevating the ribs produces an inspiration that fills the lungs. A decrease in the size of the thorax either by elevating the diaphragm or by lowering the ribs results in the forcing of air from the lungs—expiration. "At the end of the inspiration the ribs and diaphragm are brought back to normal position by purely physical forces, the elasticity of the distended abdominal wall, the elasticity of the expanded lungs, the weight and torsion of the ribs, etc." (Howell.) In quiet ordinary breathing, the expiration is entirely passive.

The influence of the muscles used to increase the size of the thoracic cavity has no direct bearing in our particular field except possibly in cases of bad posture and poor development due to un-

Fig. 2 (Case 1).—Patient who habitually holds mouth open, but when respiration was tested was found to be nose breather. The tonsils and adenoids were removed at 5 years.

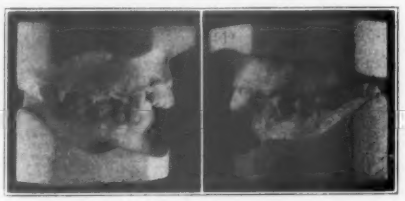

Fig. 3 (Case 1).—Malocclusion that may be classified as Class I with mesioversion of maxillary right first and second molars.

healthful habits of breathing, but the accessory respiratory movements bring into action muscles that do come under our direct observation. These are the muscles that control the opening of the external nares and those that control the size of the glottis. The posterior crico-arytenoid muscles contract to dilate the glottis at

each inspiration in the normal breathing of many animals and in man when the breathing is at all forced. The elevators of the wings of the nose function at each inspiration. This same movement is common to many animals, such as the horse, and the useful result of this movement is to reduce the resistance to the inflow of air. In the human being, the activity of M. nasalis is always directly proportional to the activity of M. orbicularis oris. Increased activity of this muscle occurs in making nonvocalized sounds such as b, p and oo and in whistling. It becomes obvious, then, that, in the treatment of malocclusion, all cases of mouth breathing or the "open mouth" habit, attention must be given to the development of M. nasalis as well as M. orbicularis oris.

Pressure conditions in the lungs and thorax have a definite influence on circulation. Under normal conditions, this pressure is always negative—that is, less than one atmosphere. "The reason for the negative pressure is simply that the lungs are distended to fill the thoracic cavity, and consequently the organs, like the heart, which lie in this cavity outside the lungs are exposed to a pressure of one atmosphere minus the elastic recoil of the lungs." (Howell.) The intrathoracic portion of the esophagus is exposed during swallowing to a full atmosphere of pressure on its interior and a diminished intrathoracic pressure. This tends to dilate the tube and may be of some aid in the act of swallowing. The act of swallowing is accompanied by a slight inspiratory movement of the diaphragm called the swallowing respiration, which is apparently a regular part of the swallowing reflex. The main effect of change in pressure is felt on the flow of lymph and blood especially.

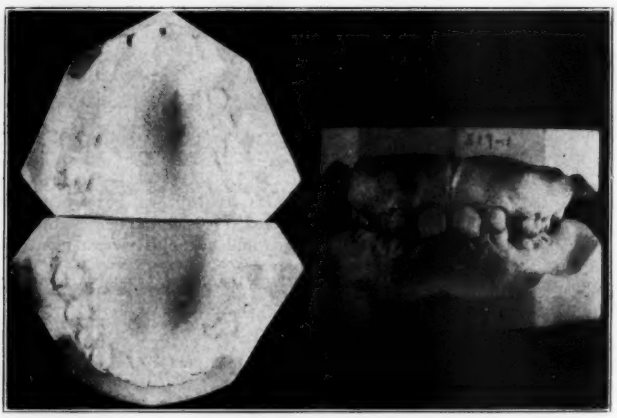

Fig. 4 (Case 1).—Left, high palate.

The mammalian fetus makes no respiratory movements while *in utero*. After birth and in the interruption of the placental circulation, the first breath is taken. The cause of this sudden beginning of activity of the respiratory center is probably closely connected with the cause of the automatic activity of the respiratory center throughout life.

The urge to breathe through the nose is very strong in the infant, but, as age advances, this tendency seems to diminish.

An interesting study was made by W. Warwick James and Somerville Hastings.[2] Fifty-three infants aged from 1 to 14 days were examined while asleep. Every one breathed through the nose entirely. Several had their lips apart and, in some of these, the space between the lips was plugged by the tip of the tongue and some were not. The noses were pinched between the finger and thumb and the babies slept undisturbed for about twenty seconds, but then began to struggle and cry. The lips were opened at the moment of crying and an inspiration was made. C. W. Richardson reports a case of congenital obstruction of the postnasal orifices of a new-born infant who kept its lips closed until its face showed the struggle for air. It would then start to cry, which opened the lips and relieved the situation. It would then settle down and be quiet until the cycle began again. As long as the lower lip was depressed, the child continued to breathe through the mouth. It was necessary to keep the lips apart by relays of assistants for a

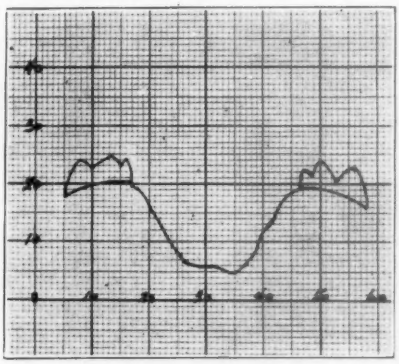

Fig. 5 (Case 1).—Shape and height in millimeters of palate in vertical plane passing through maxillary first molars.

Fig. 6 (Case 2).—Girl having Class II, Division I malocclusion, but who keeps mouth closed and breathes through nose. The adenoids and tonsils have not been removed. The patient was a breast-fed baby and had a bottle only two months. Her chin was short at birth and the protrusion was present in the deciduous dentition.

2. James, W. W., and Somerville, Hastings: Mouth Breathing and Nasal Obstruction, Proc. Roy. Soc. Med., 25, No. 4, 1932.

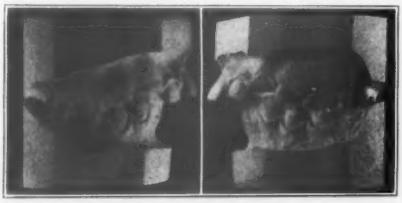

Fig 7 (Case 2).—Class II, Division I malocclusion. Attention is called to the bony ridge which extends to and includes the first molars. This is nature's method of reinforcing the bone against the strain of occlusion or against traumatic occlusion.

Fig. 8 (Case 2).—High palate, evidence of faulty tongue position.

period of two weeks before the child learned to breathe through the mouth. He ventures the suggestion that some children with a complete congenital nasal obstruction never succeed in breathing and are stillborn.

Nasal obstruction is perhaps the most common symptom of nasal disease. Unless the obstruction is complete, it may vary from time to time, or it may alternate from one nostril to the other. The state of the weather has an effect on an obstruction owing to erectile swelling of the conchae. This is true in damp weather in cases of obstruction due to the presence of polypi.

Chronic nasal obstruction in infants

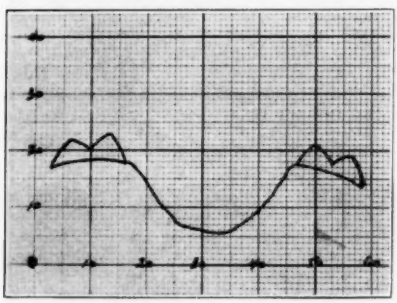

Fig. 9 (Case 2).—Shape and height of palate in vertical plane passing through maxillary first permanent molars.

may produce grave symptoms owing to interference with suckling and disturbed rest because of inability to breathe through the mouth when sleeping. Characteristic changes are produced in children and are described as "adenoid facies." (Fig. 1.) The typical patient presents the pinched nose with a flattened bridge and narrow underdeveloped nostrils. The nasolabial fold is obliterated, and there is often an eczematous condition of the skin about the anterior nares because of frequently recurring catarrh. The mouth is open, the vacant stare resulting. The upper lip is short and underdeveloped, the lower thickened and rolled outward. The palate may be v-shaped and the maxillary arch narrow. The maxillary incisors protrude and, in many cases, the mandible is in distal relation to the maxilla.

If the nasal obstruction continues long

Fig. 10 (Case 3).—Boy 6 years and 9 months of age, about size of a normal 4-year-old. The adenoids and tonsils were removed at 3 years of age, but he habitually holds his mouth open. A test of his respiration reveals that he is a nose breather.

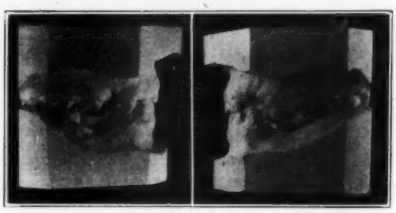

Fig. 11 (Case 3).—Class I malocclusion.

enough, changes occur in the thorax. The lower part of the chest does not expand properly, a furrow develops where the diaphragm is attached and, in rare cases, the child may become "pigeon-breasted."

Adenoids, as a common affection of

childhood, were first noticed by William Meyer of Copenhagen, in 1868.

Adenoid vegetations are hypertrophy of the lymphoid tissue normally found in the vault of the nasopharynx of the child. Adenoid vegetations are met with in early life. The most common period for their occurrence is between the ages of four and fifteen, but they may also be found in infants, and in some cases are undoubtedly congenital. (Turner.[3])

There is a tendency for these vegetations to atrophy at the age of puberty, but irreparable damage has been done by that time. We also find adenoids present in adults. Climate is a factor, for cold, damp atmosphere predisposes to the disease; whereas, in the warmer dry climate, it is not so prevalent.

The symptoms of adenoids sometimes present ear complications. The great majority of cases of deafness in children are the result of the presence of adenoids. The predominant nasal symptoms may be snoring at night, mouth breathing, a tendency to choke when eating, frequent head colds, nasal discharge, dull speech lacking in resonance, and sometimes nosebleed.

The general symptoms are poor physical development with flatness and retraction of the chest, the dental deformities mentioned before, night terrors, inability to concentrate, a tendency to tire easily, dullness and lassitude.

In normal breathing, after speaking, swallowing usually occurs. During the act of swallowing, all air is removed from the mouth and a negative pressure is established. The tongue is then against the palate, and it is possible for air to enter the mouth from only two sources, the anterior opening and the posterior opening, and then only on the failure of proper functioning of the structures that seal these openings. The mandible then drops a trifle, which tends to increase the negative pressure, or vacuum as it is sometimes called. Dewey stated that "When the mandible drops, a vacuum is created between the tongue and the roof of the mouth. The air attempts to rush in and fill this vacuum. This causes a pressure on the mandibular hyoid group of muscles which pushes on the muscles

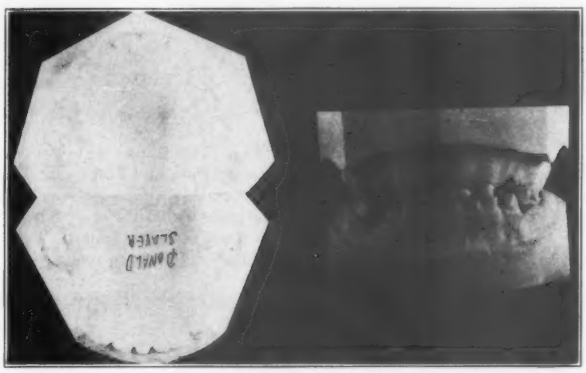

Fig. 12 (Case 3).—High palate.

3. Turner, A. L.: Diseases of Nose, Throat and Ear, Ed. 2, New York: William Wood and Co., 1927.

of the floor of the mouth." The first part of this statement, which refers to the vacuum between the tongue and the palate, may be questioned. The tongue normally is in contact with the palate. If a negative pressure is maintained within the mouth and the mandible is lowered a trifle, the tongue stays where it is and the cheeks and lips are forced inward. As long as the negative pressure exists, the atmospheric pressure assists in holding the mandible in position.

This negative pressure may be destroyed either partially or completely. If the lips are opened, it is completely destroyed. If the posterior seal is broken and air is permitted to enter from the

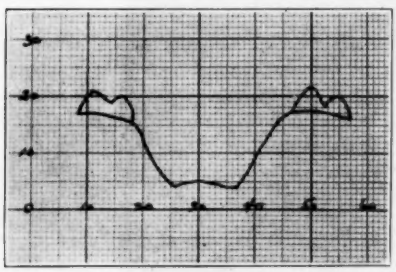

Fig. 13 (Case 3).—Shape and height of boy's palate in vertical plane passing through maxillary deciduous molars.

back of the mouth, the negative pressure is eliminated partially and air exists between the tongue and the palate. A negative pressure may still exist in other parts of the mouth, as is evidenced by the noise made by the inrush of air if the lips are forcibly pulled apart. When, from lack of muscular control, the negative pressure fails, the tongue lies on the floor of the mouth and the mouth hangs open. The muscles are relaxed and the weight of the mandible and the mandibular hyoid group of muscles pull the mandible downward and backward. This is clearly illustrated when a general anesthetic is given or when one drops off to sleep while sitting in a chair. The absence of molding influence on the palate of the tongue and the lingual pressure of the cheeks causes the maxillary arch to narrow and the palate to assume a high v-shape.

We ordinarily associate the abnormally high palate with mouth breathing, and this is usually found in the true mouth breathing type. This does not mean that

Fig. 14 (Case 4).—Boy who breathes through nose and keeps mouth closed—a normal breather. His nose was broken at 7 years of age and the left nostril is open, but not so free as the right nostril. The adenoids and tonsils have not been removed.

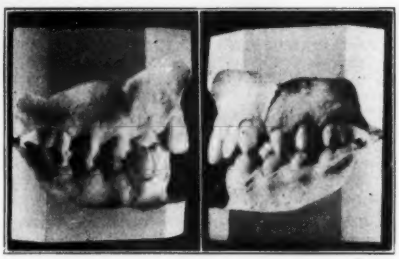

Fig. 15 (Case 4).—Class I malocclusion.

the unusual height of the palate is caused by mouth breathing, for there are many instances of a high palate in persons who are not mouth breathers. The unusual height of the palate, in my opinion, may be caused by a faulty tongue position. Naturally, this goes hand in hand with mouth breathing, but the number of per-

sons with high palates who breathe through the nose is surprising.

To give an idea of the comparative number, twenty-five cases, taken as they came, were observed. There were fourteen Class I cases, ten Class II and one Class III. Of this number, eleven had abnormally high palates. Of the eleven, five breathed through the nose entirely and with the lips closed, two breathed through the nose, but held the mouth open, three breathed through both nose and mouth with the mouth held open, and, in one, the test was indefinite. Seven were Class I and four Class II, Division I cases. In seven of these cases, a faulty tongue position was noted, and, in four cases, the occlusion was such that the tongue could not be observed clinically.

Five of the twenty-five had medium palates, that is, neither high nor average. Seven palates were average and two were lower than average.

This, it seems, would indicate that the high narrow palate is certainly not limited to Class II, Division I cases, and that it is the result probably of a faulty tongue position. Of course, the faulty tongue position is always present in true mouth breathers. An interesting observation is that out of ten Class II, Division I cases, only three were in mouth breathers and they breathed through both nose and mouth. The other seven persons breathed through the nose. Among these ten cases were only two average and one low palate.

A careful check of the breathing was made in each case by holding a strip of tissue paper about one-fourth inch wide and about 3 inches long alternately and repeatedly before each nostril and the mouth when open. In order that the patients might be unconscious of what was being done, nothing was said about the test. A second piece of paper was moved before them and they were asked to follow it with their eyes. Observation was then made without the patient's knowledge to make sure the lip position and breathing had been correctly registered.

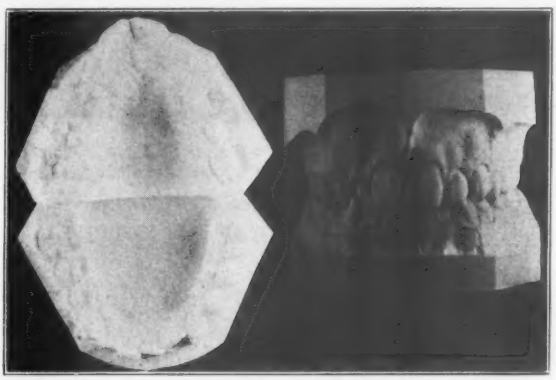

Fig. 16.—Case shown in Figure 15. The palate is very high.

These figures cannot be conclusive evidence of the statements made. Twenty-five cases is too small a number and a tongue roentgenogram should be made of all these cases. The desire to know the approximate percentage prompted this study to augment clinical observations.

For years, we have classified distoclusion, or Class II cases, into two distinct groups, namely, abnormal and normal breathing. Angle's classification describes Class II, Division I as a distal relation of the mandibular arch to the maxillary arch with protruding maxillary incisors and says, "This form of malocclusion is always accompanied and, at least in its early stages, aggravated, if indeed not caused, by mouth breathing due to some form of nasal obstruction."[4] We have accepted this statement as logical and have assumed that it is true. In the last few years, more attention has been called to the fact that many of the so-called mouth breathers are really breathing through the nose.

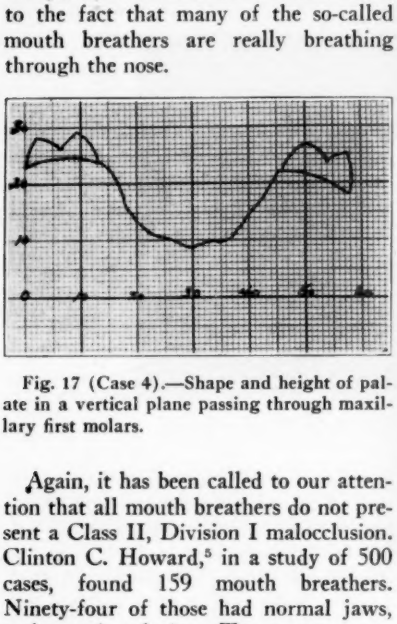

Fig. 17 (Case 4).—Shape and height of palate in a vertical plane passing through maxillary first molars.

Again, it has been called to our attention that all mouth breathers do not present a Class II, Division I malocclusion. Clinton C. Howard,[5] in a study of 500 cases, found 159 mouth breathers. Ninety-four of those had normal jaws, arches and occlusion. Twenty-two were Class II, Division I cases; 9 were Class III and 34 were Class I. The fact that there were only twenty-two Class II, Division I cases in 159 mouth breathers makes it appear that, after all, we may have to look farther than mouth breathing to find the etiology of Class II, Division I malocclusion. Howard goes so far as to conclude: "Muscular influences (mechanical stimuli) are not so potent as is now believed. If so, a total of 159

Fig. 18 (Case 4).—Faulty tongue position. The outline of the tongue and palate is shown by white lines.

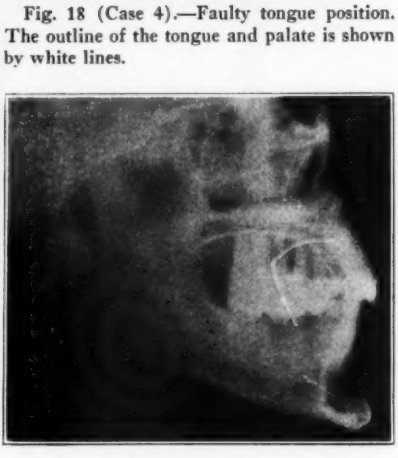

Fig. 19.—Normal tongue position after swallowing. The tongue is in contact with the palate at all points.

4. Angle, E. H.: Malocclusion of Teeth, Ed. 7, Philadelphia: S. S. White Dental Mfg. Co., 1907.

5. Howard, C. C.: Inherent Growth and Influence on Malocclusion, J.A.D.A., 19:642-651 (April) 1932.

mouth breathers would show more than twenty-two cases with Class II, Division I deformity." Again, "The open mouth is not a positive factor in producing Class II, Division I cases. If it were so, nine definite mouth breathers would not present Class III cases, the antithesis of Class II, Division I." The molding influence of muscular action in function has been quite definitely proved by experiment. Wolf's law is simply the modification of structure in the living to conform with the manner of use. This law has not yet been disproved and, until it is, we will have to accept it. Rogers has said that muscles in function become living orthodontic appliances. Many different combinations of musculature in abnormal function may be associated with mouth breathing or open mouth habits and produce a malocclusion quite foreign to Class II, Division I. Again, it is not difficult to conceive of an abnormal muscular function that could be a strong etiologic factor in the inception of a Class II, Division I malocclusion.

Bad posture acompanies many cases of Class II, Division I, and this causes a contraction in the length of the platysma myoides muscle. The platysma myoides muscle has no bony attachments. It is inserted in the fascia and skin of the pectoral and deltoid muscles of the chest and upper shoulder at one end, and, at the other, the facial extremity, its fibers are inserted in the orbicularis oris and some of the other muscles on or near their entrance into the orbicularis oris. This has a tendency to stretch the weakened muscles of the face; which may alter the bony structure of the face of the child. This condition is more marked in the true mouth breather, but may have a possible influence also in some open mouth persons that are not mouth breathers. Development of this muscle must be a part of the treatment of any case of malocclusion when posture is involved.

## CONCLUSIONS

1. The difference of pressure of one atmosphere within the esophagus and a diminished intrathoracic pressure may be of some aid in swallowing.

2. The urge to breathe through the nose is very strong in the infant.

3. Nasal obstruction is perhaps the most common symptom of nasal disease and, if continued long enough in children, will produce characteristic changes described as "adenoid facies."

4. The loss of negative pressure within the mouth is probably responsible for the lack of molding influence of the tongue, which in turn may be responsible for the narrow maxillary arch and the high v-shaped palate.

5. The open mouth and high palate are not indications of mouth breathing.

6. Mouth breathing or open mouth may be associated with any type of malocclusion.

7. Angle's statement that Class II, Division I is always associated with nasal obstruction should be modified.

180 North Michigan Avenue.

# RECENT ADVANCES IN THE KNOWLEDGE OF DRUGS AND THEIR APPLICATION IN MODERN DENTAL HEALTH SERVICE*

By WILLIAM H. O. McGEHEE, D.D.S., M.D., F.A.C.D., New York City

THE development of dentistry as a health service during the past decade has been truly marvelous. The research of numbers of devoted and able men and women has brought to us increased knowledge of the minute structure of the tissues of the oral cavity, of the physiologic and metabolic influences concerned with the development and growth of these tissues, of the etiology and pathology of processes occurring here and of methods of prevention and treatment through drugs and other means. Coincidental with these developments have been rapid advances in the field of experimental and applied pharmacology, with the addition of many new remedies to our armamentarium for the combating of disease processes.

If we could but visualize the origins of many of the metals and metalloids and of the ofttimes beautiful and fragrant plants from which large numbers of the remedies used in the prevention and treatment of the ills of mankind are derived (from valley and mountain, hill and plain, meadow, marsh, brook and river), and if we could, with the mind's eye, follow the marvelous chemical and physical changes resulting from the reactions to the minute elements of these mineral substances, or of the life principles of the cells of these plants, of the cells of the human organism, our frequent indifference and ennui would be changed to enthusiastic interest at the unfolding of this remarkable drama. The story of the artificial development and construction by man of synthetic substitutes for many of these God-given remedies, and the extraction of life-giving hormones from the organs of some of the lower animals for the up-building and nutrition of the tissues of the body, reads like a beautiful romance. The history of the development through the ages of our present knowledge of the treatment of disease is one of the most interesting of narratives. All of these considerations combine to make an engrossing tale, well worth the telling.

## HISTORICAL DEVELOPMENT OF PHARMACOLOGY AND THERAPEUTICS

The use of remedies for the treatment of disease originated when man first began to disobey the laws of health, and is as old as the human race. The forbidden fruit that Eve was tempted to eat was probably not an apple at all, but some substance deleterious to health. Thus were digestive and other disturbances inaugurated, the treatment of which probably fell to the lot of Adam, constituting him the first physician. When Pandora, through unappeasable curiosity, lifted the lid of her mythical box, pain, misery, disease and death were

*Read before the Section on Operative Dentistry, Materia Medica and Therapeutics at the Seventy-Seventh Annual Session of the American Dental Association, New Orleans, La., Nov. 6, 1935.

scattered broadcast throughout the world. The only thing she managed to hold back was Hope.

All phases of folkways, folklore, folk-medicine and ancient medicine have been similar in tendency, differing only in unimportant details. Of the beginnings of these, we really know little. We may assume that prehistoric man differed little from primitive man, a savage ruled by animal instincts and endowed as are the lower animals with a certain crude knowledge of hygienic precautions. Animals lick their wounds, limp on three legs if one is injured, hide in holes if sick, exercise in the sun, attempt to destroy parasites on their bodies and eat certain grasses and herbs when ill. These defensive actions were as instinctive in prehistoric and primitive peoples as in the lower animals.

In all medical folklore, religious and medical beliefs have been inseparable, and the idea has long existed that spirits, devils and supernatural agencies have been concerned in the production of disease and death. Winds, clouds, storms and earthquakes were manifestations of the wrath of gods, demons and spirits. Consequently, it is but natural that worship of the sun, moon, stars, fire, water and other agencies, and later the lower animals, and finally stones and idols, resulted. At first, man regarded disease as an evil spirit, or the work of one that must be appeased by burnt offerings and sacrifice. Later, through association of ideas, he was led to believe it was produced by a human enemy with supernatural power, which must be warded off by sorcery and appropriate spells. A third view was that it was the work of offended spirits of the dead, men, animals or plants. Savages readily accepted all three of these beliefs, while there is a lingering belief in sorcery and the malevolent influences of ghosts in the modern peasant, negro and ignorant white. Among savages, shamanism, a belief intermediate between monotheism and polytheism, in which a Supreme Being or Great Spirit with lesser divinities or demons is recognized, early existed and still does. Hand in hand with this belief came the medicine man and witch doctor, who assumed a solemn supervision over disease, as later did the priests over religion and disease. The shaman treats disease largely by psychotherapeutic methods and autosuggestion, attempting to frighten away the disease by assuming strange costumes and terrifying aspects, shouting, raving and similar actions and providing the patient with fetishes or amulets to ward off future attacks.

In primitive man, as he advanced further in knowledge, persons demonstrating special talents for herb-doctoring, bone setting and rude surgery, including dentistry, employed these abilities as a means of livelihood. Among these persons were of course the inevitable "wise-women" of the tribe, versed in "medical lore."

The Ebers, Smith and other Egyptian papyri reveal an extensive knowledge of crude materia medica, and the same is found in the ancient writings of the Chinese, Japanese and other races. The North American Indians were well versed in the use of herbs and plants for medical purposes. The plant lore of rural England included a knowledge of the virtues of many plants, and old English poetry is full of references to their use for the cure of disease. Primitive man's wounds were dressed with moss, fresh leaves, ashes and balsams, and when poisoned were treated by cauterization or sucking. The Babylonians had fixed periods for ritual emesis and catharsis. Massage was known among many ancient nations. Hypnotism originated with the Hindus, while inoculation against smallpox was practiced long before Jenner's

time by the Hindus, Persians and Chinese. The use of hypnotics and substitutes for modern anesthetics is frequently mentioned in the Bible, the Talmud, the Arabian Nights, the Odyssey and other writings, of the Hebrews, Orientals, Egyptians, Greeks and Romans.

An important phase of primitive healing was the effect of therapeutic suggestion and the actual cure of disease through the influence of the mind on the body. Undoubtedly, many cures were effected in this manner on nervous, overwrought, highstrung and neurotic types. Color was an important factor in folk healing. Red was regarded as hateful to evil spirits and a heat producer. This idea followed the "doctrine of signatures," much lauded at one time, in which a remedy was applied on account of a fancied resemblance in shape or color to the disease or the affected organ. Certain numerals were also considered sacred or malignant by the Chaldeans and Babylonians, and this belief is still held by the ignorant. Three, or multiples of three, were considered good luck, and seven and its multiples were associated with supernatural powers. Among spoken charms were prayers, incantations, exorcism, conjurations and the use of certain mystic words, such as Abracadabra, Sicycuma, Hax, Pax and Max. The evidence is irrefutable that many cures were affected by these means, all of which was attributed to supernatural forces, but which are now claimed to be due to "the healing power of nature," *vis medicatrix naturae;* i. e., the tendency of nature to throw off the disease or to bring unstable states to equilibrium, or the capacity of sensory impressions to so influence the action of the vasomotor centers on the internal secretions of the ductless glands as to produce chemical changes in the blood, glands or other tissues necessary to a cure. Whatever the means, we do know that modern psychotherapy can produce effects in nervous patients, far above the action of drugs.

*Early Egyptian, Greek and Roman Period.*—Medical and dental therapeutics have developed hand in hand through the ages. Knowledge among the Egyptians of medical and dental remedies for the treatment of disease was far in advance of that of other nations. The first Egyptian physician to be recorded in history was Imhotep, whose name signifies "He who cometh in peace." In all nations and primitive peoples, the early period of popular medicine was followed by the practice of sacerdotal medicine by the priests or holy men, in which cures were accomplished through prayer and sacrifice, strange and often nauseous remedies, and through suggestion. The Ebers papyrus, written in 1550 B.C., mentions medical, dental and gingival maladies, with suggestions for their treatment. Some of these date back supposedly to 3700 B.C. Neither the Bible nor the Talmud, nor any of the early Hebrew writings, specifically mention dental remedies. Herodotus, the Greek historian, mentions dental specialists as practicing in Egypt in the fifth century B.C. The Emperor Honang-ty, founder of Chinese medicine, writing twenty-seven centuries before the Christian era mentions the use of crude remedies for oral diseases. Asclepias (Aesculapius), the Greek god of medicine, supposedly lived between the twelfth and thirteenth centuries B.C. His priests, known as Aesculapii, practiced sacerdotal medicine, and to one of them, Podalarius, is attributed the discovery of the extraction of teeth. Hippocrates (fifth century B.C.), frequently called the father of medicine, often referred in his writings to remedies for the treatment of maladies of the teeth. Later, both in Greece and in Rome, there were "shops"

where medicine, surgery, pharmacy and dentistry were practiced.

Among the Romans, the practice of medical and dental therapeutics was well advanced for that time. Numerous references to dental therapeutics are found in the works of Asclepiades (founder of the "methodic school"), Cornelius Celsus, Pliny, Scribonius Largus (who devoted the tenth chapter of a book to the treatment of odontalgia), Andromachus the Elder, physician to Nero (who devised his celebrated "theriac," a remedy against all poisons and most diseases), Galen (second century, B.C.) and Paul of Aegina (seventh century A.D.). The "theriac" of Andromachus was a modification of an older remedy, the "mithridate" of Mithridates, king of Pontus (132-63 B.C.), which contained eighty-five constituents. In the fourth century before the Christian era, Aristotle often mentioned in his writings the use of remedies for dental and oral disturbances.

*The Middle Ages and the Renaissance.*—Now began the period of monastic medicine, in which there grew up a belief in the miraculous healing powers of saints and holy relics. Medicine and surgery became divorced and soon reached a low ebb. Surgery and dentistry were practiced by barbers and lackeys, while much of medical practice was for a while under the influence of the Church, supernatural aid becoming more and more esteemed. On the other hand, alchemists had arisen, with their persistent search for the philosopher's stone, which would transform all metals into gold and cure all diseases. In this search, their ridiculous nostrums were dispensed as today to sick and well alike. Rhazes of the ninth and Avicenna of the tenth centuries, both Arabians, mention the use of remedies for dental ills. Medicine was lifted to a somewhat higher plane in the eleventh and twelfth centuries by the organization of the School of Salerno in Italy. From the thirteenth to the fifteenth centuries, the Italians, French and English made slight advances in medical learning, and Valescus of Taranta (Italian), Guy de Chauliac (French) and John Gaddesden (English) are among prominent names in the medical and dental history of this period, since both dental and medical therapeutics are discussed in their writings.

The School of Spagirists was founded near the end of the fourteenth century and reached its zenith with Paracelsus (Swiss), Vesalius (Flemish-German) and Ambrose Paré (French). The Spagirists insisted on the virtues of silver, antimony, arsenic and chemicals in general, thus being opposed to the Galenists, who used only organic drugs.

The period of the Renaissance represents the beginnings of the revival of learning and of individual research. In addition to those previously mentioned, the names of Walter Herman Ryff of Strasbourg, Andrew Vesalius of Brussels, Gabriel Fallopius and Bartolomeus Eustacius are outstanding in this period. All of these men contributed to the knowledge of the teeth, in addition to their other important work. The belief that dental worms caused toothache; superstitions; the use of signs and amulets, and the marvelous power of suggestion were still rife. The use of tobacco, either smoked or chewed, for the relief of odontalgia; of ashes as a dentifrice, and of sulphuric acid as a tartar and stain remover was advocated. Some of these practices are still with us.

*Modern Times.*—Total emancipation from all drugs, therapeutic nihilism, was the next significant step taken, with the establishment of the Vienna School by Gerhard van Swieten in 1745. He, Skoda (1805-1881), and other advocates of this idea claimed that it was necessary to bury the accumulated refuse of drug

worship, quackery and superstition of the centuries and begin anew. Another reaction against excessive drugging and the "shotgun" prescription was the establishment of the school of homeopathy by Samuel C. F. Hahnemann, of Leipsic, in 1796. This is a system, still popular, founded upon the belief that drugs have the power of curing morbid conditions similar to those that they have the power to excite, an older belief existing previously to Hahnemann's time and expressed in the Latin phrase *similia similibus curantur* (like is cured by like). In practice, homeopathy is associated with the system of administering drugs in infinitely small doses, in contradistinction to the regular school of medicine and the common method of treating disease, which is sometimes known as allopathy. The eclectic school of medicine was founded in the United States in 1826 and is still represented by a number of colleges. The first "regular" school of medicine (allopathic) in this country was founded in 1765 by the medical faculty of the University of Pennsylvania, while the first dental school, the Baltimore College of Dental Surgery, was established in Baltimore, in 1840.

Dentistry really became a separate specialty during the eighteenth century, when Pierre Fauchard (1690-1761), a Frenchman, lived and wrote on dental subjects. Thus was France the cradle of modern dentistry and Fauchard its "father." His principal treatise "Le Chirurgien Dentiste" contains many prescriptions for the cure of oral pathologic conditions. He preceded or was contemporary with such men as Bourdet and Jourdain of France and John Hunter and Benjamin Bell of England, all of whom contributed to our early knowledge of dental pharmacology.

The reestablishment of medical and dental therapeutics, founded now upon reason, gradually became an assured fact, it being the result of an increasing knowledge of anatomy, histology, physiology and the pharmacologic action of drugs. Soon followed the isolation of the active principles of drugs (led by the discovery of morphine in 1805), succeeded by animal experimentation, by means of which modern pharmacology has largely developed.

John Jacob Wepfer (1620-1695), of Schaffhausen, Switzerland, presented in his book, "History and Toxicity of the Water Hemlock," the first orderly and critical presentation of pharmacologic experiments on a large scale. The work of Wepfer was followed by that of his pupil, John Jacob Harder, of Basle, Switzerland, who published in his book "Apiarium" the results of numerous animal experiments with drugs. Other names that should be mentioned in the slow evolution of modern pharmacology are those of Menghini, who in 1755 investigated the actions of camphor on animals; Felix Fontano, who in 1765 performed more than 4,000 animal experiments with snake venom; Peter John Andrews Daries, who in 1776 published his thesis "On Atropa Bellodona," and William Withering (1741-99), English physician, who in 1785 published his monograph, "Account of the Foxglove," which showed the results of his experiments with digitalis in the treatment of dropsy.

With the introduction of improved methods and technic in chemistry and physiology in the early nineteenth century, modern pharmacodynamics was made possible. Frederick W. H. Serturner (1783-1841), of Einback, Germany, studied the chemistry of opium from 1805 to 1817 and isolated morphine. He is thus credited with inaugurating the discovery of alkaloids. His work in this field was followed by that of Pelletier and Caventou, Magendie and

Ladenburg, who isolated other alkaloids, and by that of Liebig and Wohler (German), who isolated the first glucosides. The work of Magendie was followed by that of the great psychologist, Claude Bernard, who discovered the locus and modes of action of several opiates, and further corroborated Magendie's experiments with strychnine.

Rudolph Buchein (1820-1879), of Dorpat, the first professor of pharmacology, founded the first independent pharmacologic laboratory, at Dorpat University School of Medicine. Oswald Schmiedeberg, of Strasbourg (1838-1921), introduced methods for the study of drug action on isolated organs, and Carl Bing (1832-1912), of Bonn, studied the action of alcohol, volatile oils, quinine and arsenicals. Sir Thomas Fraser (1841-1920), of Edinburgh, studied the cardiac action of strophanthus and Sir Thomas Lauder Brunton (1844-1916), London, introduced the nitrites as vasodilators.

The pioneers of pharmacology in America have been Arthur Robert Cushing (1866-1926), formerly professor of pharmacology at University of Michigan, and John Jacob Abel (1857), formerly occupying the same chair at Johns Hopkins University. These, the first two independent professors of pharmacology in America, have contributed much to the advancement of this science. The first course in dental pharmacology given in an American dental school was organized and taught by me in the dental department of the University College of Medicine (now the Medical College of Virginia,) beginning with the session 1900-1901.

Rational therapeutics is now being rapidly placed on a firm basis, working hand in hand with psychotherapeutics in the treatment of disease. The value of suggestion can no longer be denied. It is a strictly scientific method, employed by many physicians and dentists as "the faith in doctors and medicine" and as "personal influence."

## THE CELL

The manifestations of the life processes are dependent on the inherent physical, electrolytic and chemical reactions of the constituents of the cells of the body to environmental stimuli. In the words of Torald Sollman:

> The living cell may be considered a very complex laboratory, where chemical decompositions and syntheses, reductions and oxidations, etc., are constantly going on. These chemic changes lead to transformations of energy which find their final expression in the phenomena of life. The vital manifestations of the cell are, therefore, inseparably connected with physico-chemical transformations, which require for their occurrence the existence of certain chemic and physic conditions. The chemic essentials are: the presence of substances capable of liberating energy and the conditions suitable for their reactions, such as a proper temperature, alkalinity, presence of ferments, etc. The physical conditions of life are: a viscid medium, containing colloid proteins, salts, fats, and water.

George W. Crile, of Cleveland, claims to have succeeded in synthesizing living cells in the laboratory. According to him, the three factors of the living cell essential for their formation, growth and function are lipoids, proteins and electrolytes. He found that lipoids and proteins taken from the brain of freshly killed animals and mixed with electrolytes made from the salts of the brain matter, united vigorously and formed cells. These autosynthetic cells possessed the properties of nucleation, growth, division, respiration, stainability, motility and production of urea, characteristic of living organic cells. The production and form of these cells seemed to depend on the $p_H$ value of the

electrolytes, the optimum resulting when the hydrogen-ion concentration was near the alkalinity of the blood.

The recent epoch-making invention of an artificial heart-lungs apparatus by Alexis Carrell and Charles A. Lindbergh is of particular importance in this connection. By means of this complicated system of glass tubes and connections, human and animal organs can be kept alive indefinitely after death, for observation and study. With it, it is now possible to make studies under controlled conditions, of the behavior and reactions of the cells of these organs when artificially perfused with sterile solutions of various types. With it, we shall undoubtedly learn more than is at present known about methods of promotion of cell development, detoxication, regeneration, etc.

What is to be the outcome of these remarkable experiments, no one can predict. Undoubtedly, they will have a very definite bearing on the unraveling of the mysteries of the physical, chemical and electrolytic reactions of the cells of the body in health and disease and the manifestations resulting from the action of therapeutic remedies on these cells. At the present time, we know really little about these matters. It has been aptly said that "the discontent of science leads to the constant investigation of natural phenomena and the answers to these constant questionings are being recorded day by day in our book of knowledge of life and the manifestations of cell reactions."

## MODES OF ACTION OF DRUGS

We have seen that the use of remedies for relief of disease was almost entirely empiric up to the latter part of the nineteenth century. The science of modern pharmacology may be said to have been based on Virchow's conception of cellular pathology and its introduction into medicine in 1858. Since that time, many advances have been made through the untiring efforts of numerous scientists, many of whom have worked unsung and with little funds, year in and year out, searching for the unknown. Much is still to be learned, but, slowly and gradually, therapeutics is being placed on a rational basis.

Drugs may act either physically or chemically, or by a combination of both methods.

*Physical Actions.*—In these, no chemical action occurs between the drug and the tissues, the results being obtained entirely through physical means. The most important of these means are (1) osmotic effects, or salt actions of hypertonic, hypotonic or isotonic solutions; (2) the absorptive or adsorptive effect of carbon, infusorial earths, dyes and colloids generally, and (3) the protective effect of gums, mucilages, collodions, oils, dusting powders and similar substances.

*Chemical Actions.*—In these, the drug exerts a chemical reaction within the body. The nature of this action may be either combination or substitution, in which there is either a combination of the drug with the tissue or with secretory products, or substitution of a new chemical compound for existing ones.

*Quantitative Action of Drugs.*—The changes produced through drug action are purely quantitative. They consist in either stimulation or depression of the functions of the cells of which the tissues are composed, such as conduction and sensation (nerves), contraction (muscles), digestion, absorption, assimilation, secretion, excretion (nutrition) and reproduction. Since drugs are incapable of changing function or imparting new properties to matter, no such changes are possible through this means. A violent stimulation often results in injury, such injurious stimulation being called irritation.

*Reaction Between Drug and Cell.*—

Knowledge of the exact reactions occurring between drug and cell is as yet meager. Four theories are at present prominently advanced:

1. In some instances, the drug does not penetrate the cell wall, but superficially forms a combination with it.

2. In other cases, the drug does penetrate the cell membrane and enters into chemical combination with its protoplasmic contents.

3. Sometimes, the drug may penetrate the cell wall, but, not chemically uniting with the cell contents, may physically change their nature and thus stimulate or depress their functions.

4. Certain drugs, through adsorption, cause a change in the surface tension of the cell in relation to the surrounding fluids, with resulting elevation or lowering of functional activities of the cell.

### PHARMACEUTIC STANDARDS

The strength, purity, methods of preparation and usefulness of pharmaceutic products are obviously important as a protection to those prescribing them, and to the public. These matters are now regulated by law in most civilized countries.

Proprietary drugs are nonofficial remedies, many of which are protected by patents, trademarks, secrecy of formula, etc., usually advertised to the profession only. Although many of them are valuable remedies and substitutes for official preparations, ethically manufactured and advertised, some are advertised with misleading, extravagant and false claims. Patent medicines and dental nostrums are proprietary unofficial drugs, often of secret formula, advertised to the laity, as well as to the profession, many having suggestive therapeutic names, of the "cureall" variety and possessing little real value. Large numbers of these have been proved absolutely fraudulent.

Through the activities of the Council on Pharmacy and Chemistry, the Committee on Foods, the Bureau of Investigation and the Chemical Laboratory of the American Medical Association, during the past twenty-five years, physicians have been educated as to the importance of prescribing official or acceptable remedies and the public has been repeatedly warned against the indiscriminate use of fraudulent preparations. The Pure Food and Drugs Act of the National Government provides for the prevention of the manufacture, sale or transportation of adulterated, misbranded, poisonous or deleterious foods, drugs, medicines and liquors, and for regulating traffic therein. The Food, Drug, and Insecticide Administration of the U. S. Department of Agriculture has for a long time been active in eliminating the malodorous situation that has existed in this regard in this country. As a result of these activities, much good has been accomplished. Their field of activities having been limited through these various agencies, unscrupulous drug manufacturers have increasingly devoted their attention to the dental profession and the laity, through the fostering of dental nostrums, "curealls," dentifrices, pyorrhea "cures," antiseptics, anesthetics, tooth-bleaching agents and similar frauds.

Recognizing the need for supervision of these activities and exposure of fraudulent or improperly advertised dental remedies, the Bureau of Chemistry of the American Dental Association was organized, through cooperation with the similar bureau of the A.M.A., in 1927. In January, 1930, the Council on Dental Therapeutics of the A.D.A. was organized. Through the unselfish, devoted efforts of this group of men, valuable service is being rendered in stamping out fraud, and in education of the dental profession as to the importance of

using and prescribing acceptable and rational remedies and of the public regarding the ridiculous and unscientific claims of unscrupulous manufacturers of dental nostrums and patent dental medicines.

*Accepted Dental Remedies (A.D.R.).*—The findings of the Council on Dental Therapeutics are at present being published monthly in THE JOURNAL. A book, Accepted Dental Remedies, which has recently gone into a second edition, includes remedies complying with the rules of the Council. This book will continue to be of great aid to the profession in using and recommending dental remedies of known composition, pharmaceutic action and therapeutic effect. Already, a formidable list of fraudulent dental preparations have been exposed by the Council or by the Bureau of Chemistry.

## CONCLUSION

During the past several years, the Section on Pharmacology of the American Association of Dental Schools has been interested in fostering a greater unification of the teaching of materia medica, pharmacology and pharmacotherapeutics in the dental schools. Free discussions on and investigations of this subject showed wide diversity in course-content, number of hours devoted to it and the character of the teaching in classroom, laboratory and clinic in the various schools.

As a dental school executive, as a teacher of materia medica, pharmacology and therapeutics for many years, and as a clinician, I took an active part in these debates, presented several papers and discussions before the section and was made a member of a committee, with Gerald D. Timmons as chairman, to make a survey of existing conditions. The results of this survey were tabulated and referred to the Curriculum Survey Committee of the American Association of Dental Schools. The final report of this committee has recently come from the press.

In this excellent report, the committee has made definite recommendations as to objectives, course-content, clock hours and methods of presenting the subjects of materia medica, pharmacology and pharmacodynamics in the dental schools. These recommendations are based on the findings of the Committee on Survey previously appointed by the Section on Pharmacology, and of a subcommittee on pharmacology of the Curriculum Survey Committee. Since this report will undoubtedly produce greater unity in teaching this subject, I am heartily in accord with most of its provisions, and I am convinced that great improvement will be made in the courses of instruction in this subject in the dental schools. Thus will the younger generation become better educated in this important field.

I have followed with deep interest and have been in close touch with the work of the Council on Therapeutics of the American Dental Association in promoting an ever-increasing interest in, and knowledge of, the rational administration of drugs in dental therapeutics. The inspiring work of the members of the Council and of its secretary deserves the everlasting gratitude of the profession. Its far-reaching influence cannot be overestimated. A copy of the current edition of Accepted Dental Remedies, the U. S. Pharmacopeia and the most modern text on dental pharmacology should be in the library of every dentist who wishes to keep abreast with the remarkable advances being made in this field.

Some features of the recent tendency to criticize the pharmaceutic manufacturing houses are ill-advised. Of course, there are quacks and frauds in this field, just as there are in medicine and dentistry. The dental profession is unjustified in making an apparent blanket indictment against

the drug manufacturers as a class because there are black sheep in their midst. Many of these houses are conducting their affairs on a high ethical plane in an endeavor to serve the best interests of the dental and medical professions. Some of them have been in existence since the early beginnings of organized dentistry in America, have served with integrity and honesty and have contributed much toward the growth and development of our present knowledge of drugs. Instead of criticizing we should be working with the latter type, in order that our mutual interests and the interests of the public whom we both serve may be fostered.

DISCUSSION

*Gerald D. Timmons, Indianapolis, Ind.:* No more important subject confronts the profession of dentistry today than the rational application of our knowledge of drugs to the conditions that are met in the daily routine of practice. It is with regret that I review some of the practices that existed in the past and it is with shame that I review some of the practices that are prevalent today. The regrettable feature is that no reason can exist for any practitioner of dentistry being uninformed. Dr. McGehee has brought out the fact that the needs of the profession are amply provided for by formation of the Council on Dental Therapeutics, publication of Accepted Dental Remedies and the report of the Curriculum Survey Committee of the American Association of Dental Schools. Two separate and distinct classes must be provided with proper information in regard to the advances in knowledge of the use of drugs, the members of the profession who have been practicing so long that knowledge obtained during their college careers is by now archaic, and the dental student of today. By the proper use of the three agencies mentioned by Dr. McGehee, these two classes can be properly informed and only the indifference of the individual can prevent his acquiring the information. First, in considering the practitioner, too much cannot be said in condemnation of the empiric practices that are permitted to continue in many cases today. There can be no excuse for them. With the reports of the Council on Dental Therapeutics available in practically every issue of THE JOURNAL, it is thus possible for the practitioner to be well informed on the strides that are being made in the study of this all important subject. Changes do occur, and only by reading current material is it possible to keep abreast of the times. In addition to these reports, there is the annual publication of Accepted Dental Remedies. No person should conduct a general practice of dentistry without availing himself of the knowledge presented by this volume. There is not a practitioner in this room today who would not get value received for the information given on the pages from 199 to 203 inclusive. The section I refer to is the section entitled "Formulas and Prescribing Suggestions." As has been stated, it is possible for every practitioner who utilizes the above mentioned agencies to be well informed on the application of drugs in the practice of dentistry. The third agency mentioned has to do with the education of the student who is to be the practitioner of tomorrow. The Curriculum Survey Report is the most important forward step that has been made in dental education in a long period. Not only the subject under discussion has been surveyed and outlined, but also every subject which, in the opinion of the Committee and its co-workers, should be taught in a dental school has been carefully surveyed and outlined. By the application of these outlines, it will be possible to bring about a better standardization of teaching and, in a measure, strengthen every course taught in a dental school. Every teacher of pharmacology has at his fingertips an outline devised to foster a more comprehensive knowledge of the subject, which can result in but one thing—a better foundation on which to build the superstructure, the materials for which will be supplied by experience. Dr. McGehee spoke of a blanket indictment of the manufacturers. It must be realized, as he states, that all manufacturers do not fall

in the class in need of indictment, but it must also be realized that if it were not for our ignorance and gullibility, there would be no call for some of the products manufactured. This, of course, does not include those products that are offered to the public in a direct manner. These must be dealt with by means of the education of the patient, and this education is not successfully carried out by dispensing samples of any and all remedies that may have been left by a detail man. We must overcome the apathy that exists and only by doing this can we place our profession on the proper plane.

*R. S. Vinsant, New Orleans, La.:* It has been very interesting to follow Dr. McGehee's story of the advance in the knowledge of drugs and their application, from the beliefs in witchcraft and slight of hand performances, to a rational use of these drugs. He has shown in a very forceful manner the gradual development in this science. Since he has been a teacher so many years, and since he was the first teacher to give an organized course to dental students in pharmacology, about thirty-five years ago, and since he has maintained his interest in this subject all these years, he is peculiarly fitted to bring to us this message. His intimate knowledge of operative Dentistry, with its attendant pathology and bacteriology, further equips him for writing on this subject. Most of us studied drugs and their application from textbooks, and more as a memory lesson, in the past. Very few schools gave laboratory courses in this subject, affording the pupils an opportunity to study the inherent physical and chemical reactions of the body to drug and environmental stimuli. The number of drugs used by a dentist are few as compared to the many that are found in the textbooks on materia medica and therapeutics. But every dentist should have a sufficient knowledge of those drugs that he needs in his practice. The dental curriculum survey committee said, in its recent report, "A study of materia medica without an adequate foundation in chemistry cannot go beyond empiricism." Therefore, in order to understand this part of our drug development, it is necessary to know chemistry. A rational drug application is what we all seek. I should like to emphasize the importance of an increasing knowledge of the cell and the reactions of the cell to drug stimuli. We cannot get very much farther in drug therapeutics until we know more about the cell. In order to do this, we must know: (1) the nature of normal cell or tissue; (2) the chemistry of the cell; (3) the physiology or function of the cell, and (4) the reaction of the cell to environmental stimuli. Also, we must study the modes of action of drugs to be used for specific types of disease. In doing so, we might ask: 1. Shall it be physical? 2. Shall it be chemical? 3. Shall it be both? 4. Shall a systemic application of drugs be made? 5. If so, what will be the mode of action of the systemic drugs? There are drugs that can be used, but we should endeavor to determine which will give the best results with the complications involved. We have an abundance of drugs if we can only master their proper application to the diseased processes with which we come in contact. The simpler remedies are usually the best. We, as dentists, cannot introduce many new drugs. This must be done largely by the schools and manufacturers, with their immense facilities for laboratory and clinical research in this field. I agree with Dr. McGehee that the attitude of some in criticizing all drug manufacturers is unreasonable, since many of them are doing excellent work for medicine and dentistry by original research and the introduction of new drugs and combinations. Many of the drug manufacturers who create new remedies to meet new demands are honest and should not be condemned because of the black sheep in their midst. We now have a most efficient Council on Dental Therapeutics, which can always be relied on to take care of the black sheep, if we will give them our support. This is one department of the American Dental Association that needs more money and man power to more closely safeguard the dentist and the public from unscrupulous manufacturers. They are now doing a marvelous piece of work with the limited facilities at their disposal.

# INFLUENCE OF BIOLOGIC FACTORS IN RETENTION OF ARTIFICIAL DENTURES*

By ELBERT CROSBY PENDLETON, M.D.S., Chicago, Ill.

THE problems in denture retention are an obsession to many who contend with the variable conditions nature presents in the edentulous human mouth. The failures in the construction of complete artificial dentures have created the incentive for this study. There is, generally speaking, little that is intriguing in an investigation of the biologic factors in denture retention. On the other hand, the propounding of a technic arouses abounding enthusiasm. Not until the alluring technics had contributed their quota of disappointments was a solution to the problem of denture retention sought through study of the fundamental sciences.

Materials and methods avail but little when the structural characteristics of the tissues are ignored. The biologic factors in denture retention are the directing influences or controls that determine the virtue of the procedures employed in clinical practice.

In the year 1766, John Woofendale constructed for Mr. William Watson, of New York, what is believed to be the first complete dentures produced in America.[1]

From a review of the dental literature, it is evident that from the time of Woofendale to the present, the problems in denture retention have been a challenge to the proficiency of the denture prosthetist.

Of the many phases of denture construction that have attracted the interest of the profession, none have a more fundamental influence on the success of the artificial restoration than the biologic factors.

Among the works of the early writers, there are many references to the variations in the character of the denture-supporting tissues. Pearsall observed that "suction can seldom be relied upon in palates of a hard, bony nature covered with a thin fibrous gum, no matter how favorable they be in form."[2] Litch recognized the significance of tissue character as a pertinent factor in denture retention.[3] "The uniform plasticity of the tissues of the mouth" was referred to by Richardson as a factor of concern to the denture prosthetist,[4] and, in 1880, Balkwill classified jaw form as an aid in the construction of artificial dentures.[5] Study of the biologic and the mechanical fac-

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*Read before the Section on Full Denture Prosthesis at the Seventy-Seventh Annual Session of the American Dental Association, New Orleans, La., Nov. 6, 1935.

1. American Academy of Dental Science, A History of Dental and Oral Science in America, Philadelphia: S. S. White Dental Mfg. Co., 1876, pp. 2-6.

2. Pearsall, W. B.: Mechanical Practice in Dentistry, New York: Claudius Ash, Limited, 1898, pp. 174-180.

3. Litch, Wilford: American System of Dentistry, Vol. 2, Philadelphia: Lea Brothers and Company, 1887, p. 457.

4. Richardson, Joseph: Mechanical Dentistry, Ed. 2, Philadelphia: Lindsay and Blakiston, 1869, p. 105.

5. Balkwill, F. E.: Mechanical Dentistry in Gold and Vulcanite, London: J. and A. Churchill, 1880, p. 127.

tors in the retention of artificial dentures has been reported by Chapin A. Harris, Snow, Wilson, Tench, Stansbery and others who have contributed much to knowledge of the problem.

The anatomic arrangement of the structures plays an important rôle in their functional activity. It seems certain that the variations observed in a study of the minute anatomic structure of the jaws are reflected in the character of the soft tissues. The variety of tissue character seems to accompany changes in the bony framework. Bone is Nature's answer to the problem of mechanical support.[6] According to Ham, "Bone is not the fixed and permanent structure which its relative dense composition might seem to indicate. . . . its architecture changes constantly throughout life, and the remodeling which occurs after fractures offers very good evidence of its ability to accommodate itself to the work placed upon it."[7]

More than 2,000 years ago, Aristotle described the process of flexion of the muscle system and its rôle in locomotion.[8] Muscle movement is an impor-

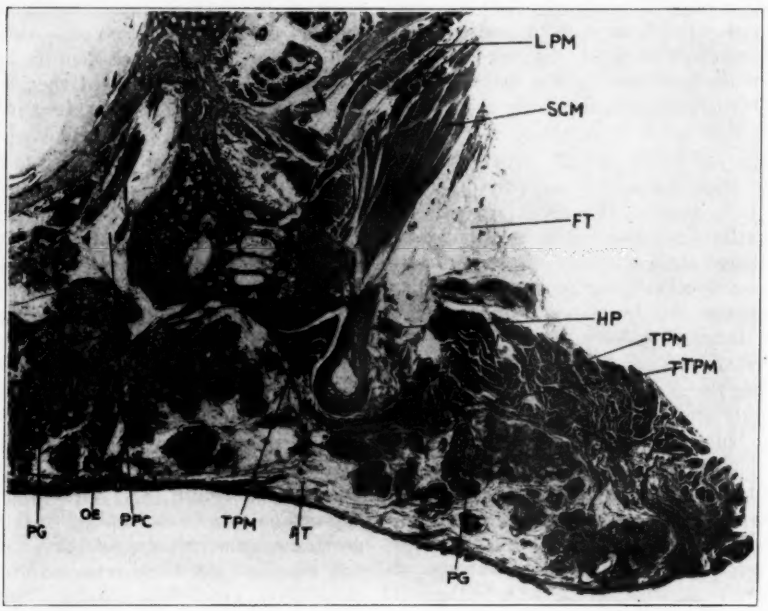


Fig. 1.—Sagittal section from region of pterygoid fossa including hamular process and pterygopalatine canal. *LPM,* levator palati muscle; *SCM,* superior constrictor muscle; *FT,* fatty tissue; *HP,* hamular process; *TPM,* tensor palati muscle; *TTPM,* tendon uniting fasciculi of tensor palati muscle; *PG,* palatine glands; *AT,* areolar tissue; *PPC,* pterygopalatine canal; *OE,* oral epithelium.

6. Cowdry, E. V.: Textbook of Histology, Philadelphia: Lea and Febiger, 1934, p. 377.

7. Ham, A. W.: Function of Bone as Calcium Reservoir, with Consideration of Cellular Pictures Seen in Resorption, with Particular Reference to Significance of Osteoclasts, Angle Orthodontist, 2:142-157 (July) 1932.

8. Footnote 6, p. 389.

tant factor in the problem of denture retention and muscle is closely associated in structure with other denture-supporting structures. About and between the muscle fibers, fat and connective tissue provide a cushion that insures their normal function. It is this cushion that is such an important element in the retention of artificial dentures.[9]

retention of the complete artificial denture. Its form is favorable and the soft tissues are usually adequate for support and distribution of the stress and shock produced by the masticating function.

The form of the area provided by the residual alveolar processes is an important consideration in the comfort of the maxillary denture. The labiobuccal-lingual

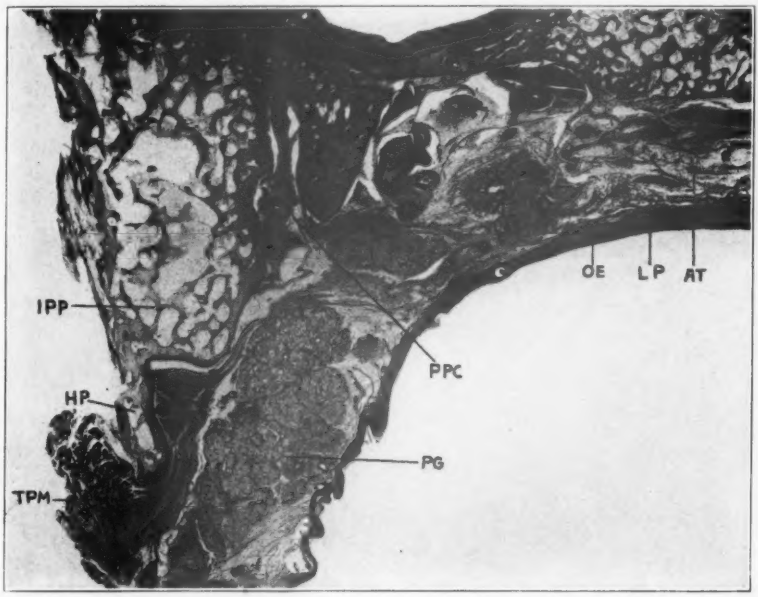


Fig. 2.—Sagittal section from region of pterygoid fossa, from specimen showing variation in character of internal pterygoid plate, hamular process and absence of tendon winding around hamular process to unite horizontal and vertical portions of tensor palati muscle. No collagenous fibers appear from its origin at the scaphoid fossa to the horizontal portion which terminates in the palatine aponeurosis. *IPP,* internal pterygoid plate; *HP,* hamular process; *TPM,* tensor palati muscle; *PG,* palatine glands; *PPC,* pterygopalatine canal; *OE,* oral epithelium; *LP,* lamina propria; *AT,* areolar tissue.

## ANATOMIC VARIATIONS OF THE MAXILLA AND ASSOCIATED PARTS

The upper jaw provides an area that is generally accepted as best suited to the dimension of the primary stress-bearing area is a feature worthy of the most careful observation and study.

Clinical observations emphasize a singular relation between the form of the residual alveolar processes and the anteroposterior extent of the hard palate.

9. Lund, Ove: Histologische Beiträge zur Anatomie des Munddaches und Paradentium, Vrtljschr. f. Zahnheilk., 40:1-21, 1924.

In jaws that present prominent residual alveolar processes, the hard palate is proportionately reduced in length. The velum or soft palate includes an area increased in proportion as the area of the hard palate is reduced. A striking contrast is seen in jaws that have a large palatine vault. The area of the soft palate is small, the size being in keeping with the general characteristics of the residual alveolar processes. Irrespective of the variations in the form and character of the velum, palatine and residual alveolar processes, a clinical appraisal of their structures may be quite definitely made when the general characteristics of their histologic structures are studied.

The form and activity of the labio-buccal and palatine muscles display characteristics that are influenced by variations in the form of the associated bony framework. The individual peculiarities observed in the musculature are often among the greatest influences in denture retention. With the exception of the muscles of the soft palate, the musculature of the upper jaw can hardly be considered as unfavorable to the retention of the artificial denture. The hazard presented by these structures is greatly reduced if the operator appreciates that the area at the posterior palatal border of the denture that is commonly affected by muscle action is limited. The muscles of the soft palate are attached to the posterior border of the hard palate by firm

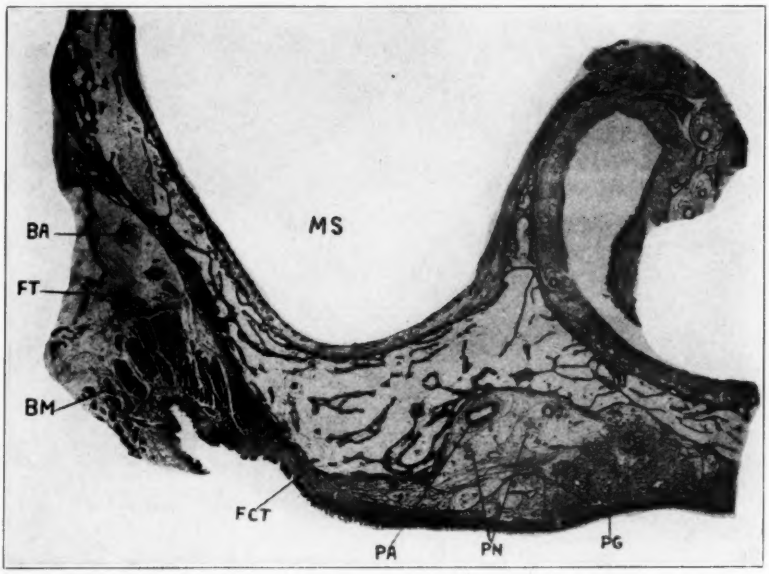


Fig. 3.—Frontal section in molar region, from specimen in which atrophic processes are evidenced by large marrow spaces in bone of residual alveolar ridge located between lines *PA* and *FCT*. Attention is called to the abundance of fatty tissue supporting the buccinator muscle, *BM*. MS, maxillary sinus; *BA*, buccal artery; *FT*, fatty tissue; *FCT*, fibrous connective tissue; *PA*, palatine artery; *PN*, palatine nerve; *PG*, palatine glands.

collagenous fibers. This seems to be Nature's method of securing the muscle fibers where the surface to which they are attached is small in proportion to the great tension exerted by the muscles. Similar fibers have been observed where the depressor septi and mentalis muscles

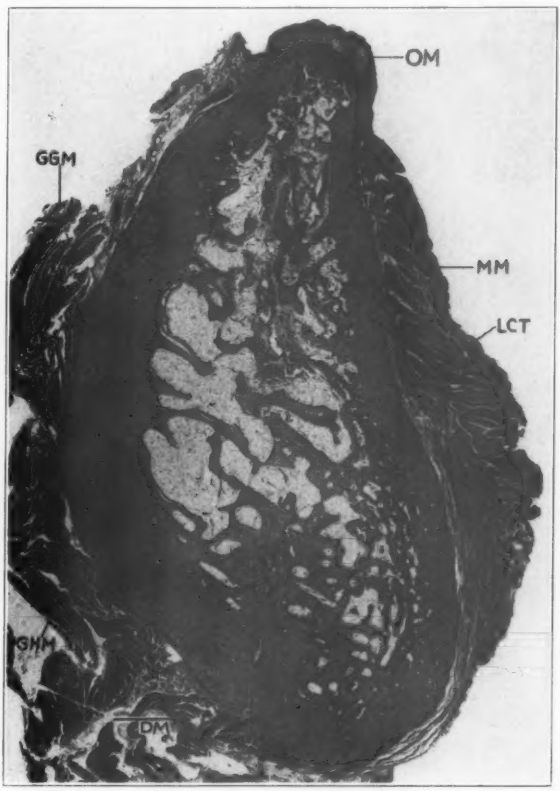


Fig. 4.—Midline section from edentulous lower jaw. *OM,* oral mucosa; *GGM,* genioglossus muscle; *GHM,* geniohyoid muscle; *DM,* anterior belly of digastric muscle; *LCT,* loose connective tissue; *MM,* mentalis muscle.

are attached to bone affected by atrophic changes.

The presence of dense strands of collagenous fibers in the submucosa invariably causes difficulty in the adaptation of the denture base. This difficulty is experienced if the aponeurosis is near the denture border. Such fiber bundles may be readily distinguished on clinical examination of the mouth as they produce a blanched appearance of the mucosa, which is normally a vivid color, owing to its vascularity. The aponeurosis at the posterior border of the hard palate is broad and produces a sharp line of

demarcation in the mucosa of the vault. This line divides the movable from the immovable structures that affect the outline of the denture border.

The palatine muscles usually display their most acute activity on either side of the posterior nasal spine. Immediately at this process, the attachments of the azygos uvulae muscles appear to have a negligible influence on the elevation and depression of the velum as it affects denture retention.

The muscles, ligaments, tendons, fat and connective tissues in the pterygoid fossa are abundant and usually limited in their activity. The pterygoid fossa forms

Fig. 5.—Midline section from edentulous lower jaw. *OM,* oral mucosa; *GG,* genioglossus muscle; *GH,* geniohyoid muscle; *LCT,* loose connective tissue; *DM,* digastric muscle with fibers attached to inferior labial surface of mandible; *MM,* mentalis.

the boundary of the denture area posterior to the maxillary tuberosity. Its size and form and the character of its bony and soft structures display great variations on the two sides, as well as in different persons (Fig. 1). In some mouths, the pterygomandibular ligament is a very elastic structure, and one of the vulnerable factors in the retention of a maxillary denture. The tensor palati muscle is likewise a disturbing factor in denture retention. In other mouths, its effect is not apparent. Its degree of tension or its lack of tension appears to be determined by the size of the maxillary tuberosity with which it is associated. Large tuberosities cause extreme tension of the velum at the posterior lingual surface of the residual ridge on the forceful movements of the tongue during deglutition. In a large proportion of the mouths examined, the structures in this region are

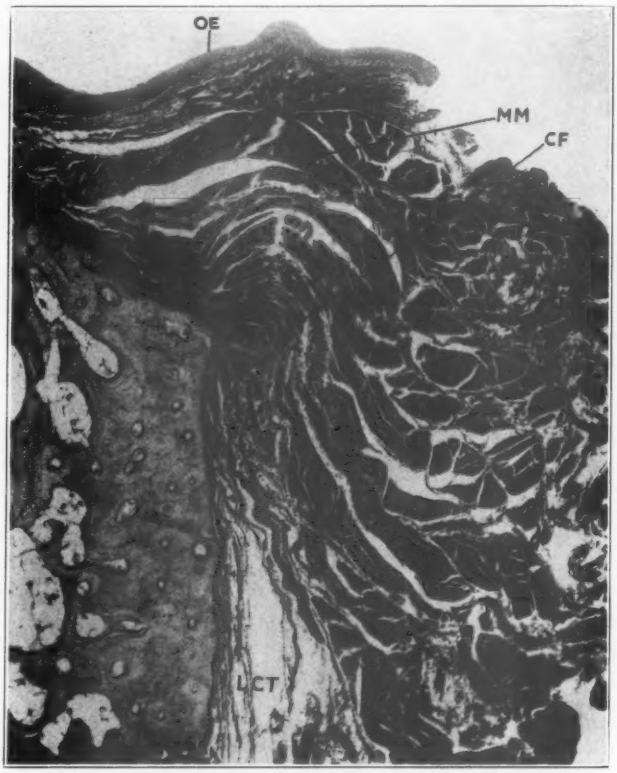


Fig. 6.—Higher magnification of superior labial portion of section shown in Figure 5. *OE,* oral epithelium; *MM,* mentalis muscle; *CF,* collagenous fibers by which mentalis is attached to spinous surface of bone.

relatively inactive and may be employed as a pad to assist in maintaining equilibrium of the denture base (Fig. 2).

The oblique fibers of the palatoglossus and the anterior fasciculus of the palatopharyngeus muscles become active where they pass the lateral surface of the azygos uvulae muscles. Their fibers that are located below the azygos uvulae and decussate in the midline are restricted in their movement. The markings in an impression of the palate produced by these muscles are not distinct until they pass the azygos uvulae on their oblique course toward the lateral walls of the pharynx. (Fig. 16.)

A definite outline conforming to the palatal muscles may be produced when: (1) the impression is taken in a plastic material; (2) the impression tray con-

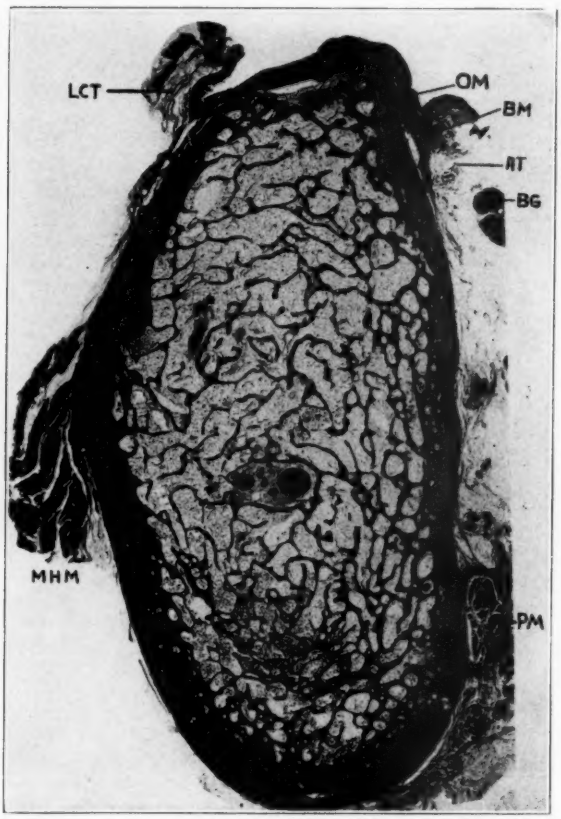


Fig. 7.—Bicuspid region from edentulous lower jaw. *LCT,* loose connective tissue; *MHM,* mylohyoid muscle; *PM,* platysma muscle; *BG,* buccal glands; *AT,* areolar tissue; *BM,* buccinator muscle; *OM,* oral mucosa.

forms closely to the form of the vault of the palate; (3) the impression material is not confined by a tray that restricts the free movement of the velum; (4) the forceful thrust of the patient's tongue, when the mandible is slightly depressed and in a state of relaxation, provides the physiologic stimulus necessary to contract the palatal muscles.

The labiobuccal muscles have little, if any, disturbing influence on the retention of a denture as far as their normal activity is concerned. The rims of the denture must be perfectly adapted to the vestibule formed by the lips and cheeks. The lack of equilibrium of the denture base is often traceable to an inadequacy in the form of the rims. The ease with which the denture may be adapted in this region is due to the loose character of the labiobuccal tissues. Of the labiobuccal muscles, the buccinator usually presents the only problem that can be considered unfavorable to successful denture retention. The buccal muscles have a broad attachment to the bone and are usually

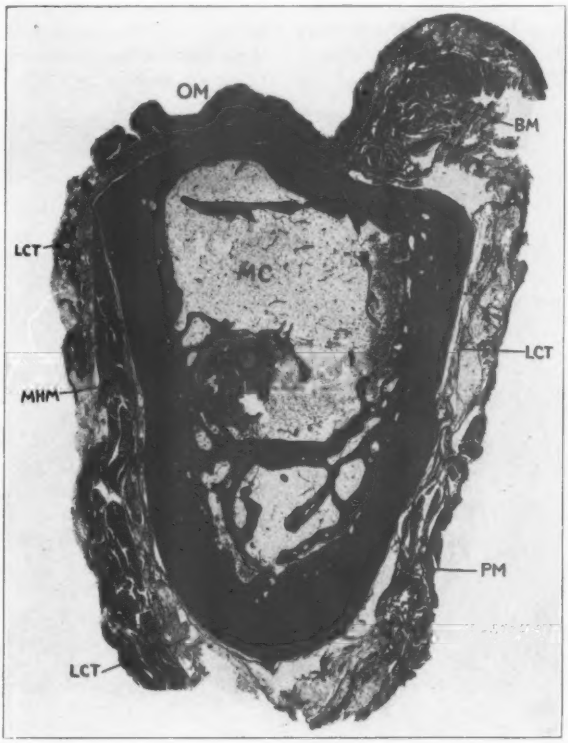


Fig. 8.—First molar region from edentulous lower jaw. *OM,* oral mucosa; *LCT,* loose connective tissue; *MHM,* mylohyoid muscle; *MC,* marrow cavity; *PM,* platysma muscle; *BM,* buccinator muscle.

well padded with connective tissue and fat; which provides a considerable degree of elasticity to the soft structures. This quality in soft tissue is favorable to denture retention. It suggests that surgical interference for the correction of low attachments of the buccal muscles is, from a full denture standpoint, an unwarranted practice. The rim of the denture may readily be adapted to these attachments without difficulty because of the elasticity provided by the fat and connective tissues. (Fig. 3.)

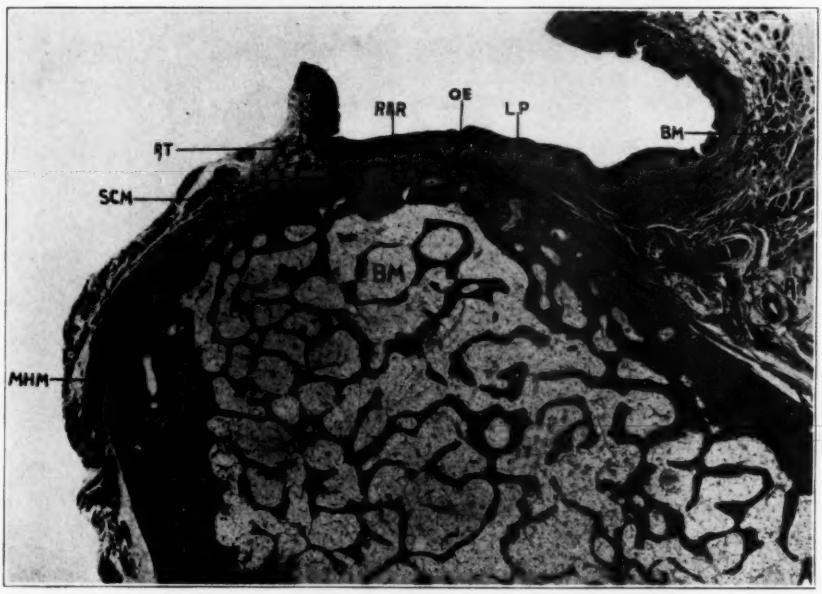


Fig. 9.—Superior surface of second molar region of edentulous lower jaw. *AT*, areolar tissue; *BM*, buccinator muscle; *LP*, lamina propria; *OE*, oral epithelium; *RAR*, residual alveolar ridge; *SCM*, superior constrictor muscle; *MHM*, mylohyoid muscle.

### ANATOMIC VARIATIONS OF THE MANDIBLE AND ASSOCIATED PARTS

The division of the mandible known as the body, with its associated soft structures, forms the supporting area for the retention of complete dentures.

The architectural form of this portion of the edentulous human mandible, unlike the maxilla, closely resembles that of the long bones. Its cortical layer of compact bone is thick and strong except at its superior surface, where atrophic changes are common. Its central portion is made up of a varying amount of spongy bone with marrow spaces supported by a network of trabeculae. The spongy bone differs greatly in character in different persons as it is affected by the absorption of its reserve calcium from the bone trabeculae.

The microscopic study of serial sections of the lower jaw reveals many variations in the form, size and distribution of the structures. Evidences of a rebuilding of

compact bone usually accompany atrophic processes in spongy bone. Many variations occur in the attachments of the muscle fibers where there is resorption in the alveolar bone. Resorption produces an erosion on those surfaces of the bone remote from the musculature tion in the quantity and distribution of the connective tissues. Therefore, the greater the amount of resorption evidenced in the bone, the more certain it is that the muscles are attached by an aponeurosis. A clinical recognition of these changes in the anatomic structure

**Fig. 10.—Superior lingual surface of edentulous lower jaw. *OE,* oral epithelium; *FCT,* fibrous connective tissue; *LCT,* loose connective tissue; *MHR,* mylohyoid ridge; *MHM,* mylohyoid muscle.**

exerting the greatest functional activity. These changes in the bony framework and in the character of the muscle attachments are usually attended by compensa- of the denture supporting tissues is a significant factor in the problem of denture retention.

The close relationship between the

form of the mandible and the character of the soft tissues of the lower jaw is particularly conspicuous in the incisor and cuspid regions. In mandibles presenting well-formed residual alveolar ridges, the mentalis muscles are attached directly to the periosteum. These attachments appear at the superior one fourth of the labial surface. From the lowest position of the attachment of its fibers, a pad of connective tissue extends downward between the muscle and the labial surface of the mandible. The fasciculus of the muscle presents little fatty tissue between its striated fibers. At the lingual surfaces in the midline, the genioglossus and the geniohyoid muscles are attached by an aponeurosis to the genial tubercles (Fig. 4).

In the incisor and cuspid regions, a small group of salivary glands, namely, the glossomandibular, lie in a shallow concavity at the lingual surface of the bone beneath the mucosa of the floor of the mouth. On clinical examination of edentulous persons, there appears a wide variation in the development of these structures. In some mouths, there is a distinct separation between the glossomandibular and the sublingual glands. In other persons, no such division is apparent. The glandular area beneath the mucosa at the lingual surface of the alveolar ridge forms a continuous structure. It has the appearance of being inflated and, on compression, may be completely collapsed. In other cases, no lingual glands are evident. The soft tissues extend from the lingual surface of the residual alveolar ridge, blending smoothly with those of the floor of the mouth. These conditions of the soft tissues are observed as the residual ridge varies in the degree of resorption of its alveolar bone.

In other microscopic sections from the incisor region of the edentulous lower jaw, there is evidence of resorption of

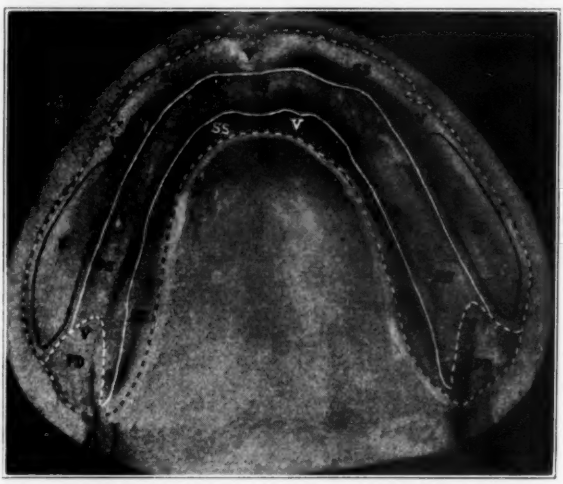


Fig. 11.—Scheme of mandibular area of denture retention. *PS*, primary stress-bearing area; *SS*, secondary stress-bearing area; *V*, valve-producing area; *PD*, postdam area; *R*, relief area.

the bone, which has reduced the residual alveolar ridge to an irregular surface that is nearly flat (Fig. 5). The glandular structures lie close to the floor of the mouth. They are large, with much fatty tissue supporting them. On the labial surface, the mentalis muscle lies close to the mucosa at the alveolar ridge. In contrast to the attachments seen in Figure 4, this muscle is attached to the bone by an aponeurosis. Between the muscle fibers regions of the mandibular arch are a source of much concern in the problem of denture retention. The impression taken of this region of the mandibular arch presents many irregularities and must conform in its peripheral development to the functional peculiarities of the movable structures.

The distribution and attachment of the tissues in the molar region also offer a wide range of variable conditions. The

Fig. 12.—Sagittal section from floor of retromolar fossa. *FCT,* fibrous connective tissue; *BM,* horizontal fibers of buccinator muscle; *RMG,* retromolar glands; *LCT,* loose connective tissue.

that appear loose and irregular in form, there is a quantity of areolar tissue (Fig. 6). In the lateral incisor, cuspid and bicuspid regions, the mylohyoid muscle, which forms the floor of the mouth, has its attachment near the lower one third of the mandible.

The variations in the form and the development of the structures in anterior form of the mandible varies in different persons and on either side in the same person. In this region, the atrophic changes in the bone are apparent only above the attachments of the buccinator muscle on one surface and the mylohyoid and superior constrictor on the other. Evidences of a change in the attachment of the mylohyoid muscle have been observed in

conditions of protracted resorption of the bone at the mylohyoid line. It may not be presumptuous to venture the conjecture that the acute prominence of this ridge is the direct result of the processes of bone resorption.[10] The prominence of this structure presents one of the most unfavorable influences in the retention of artificial dentures. The mylohyoid muscle has a varied attachment to the bone at the lingual surface of the mandible. In jaws in which resorption has not been extensive, the muscle is attached to the periosteum. From the bicuspid to the molar region, the fibers of the mylohyoid muscle extend along the lingual surface, usually from the lower border of the mylohyoid line to a position well above its superior surface. The attachment is usually broadest in the anterior regions (Fig. 7) and becomes more restricted at its posterior limits (Fig. 8). Near the second and third molar regions, the oblique fibers of the superior constrictor have their attachment above those of the mylohyoid (Fig. 9). In specimens presenting a very prominent mylohyoid ridge, the muscle is attached to the bone by long collagenous fibers that continue well above the ridge toward the crest of the mandible (Fig. 10).

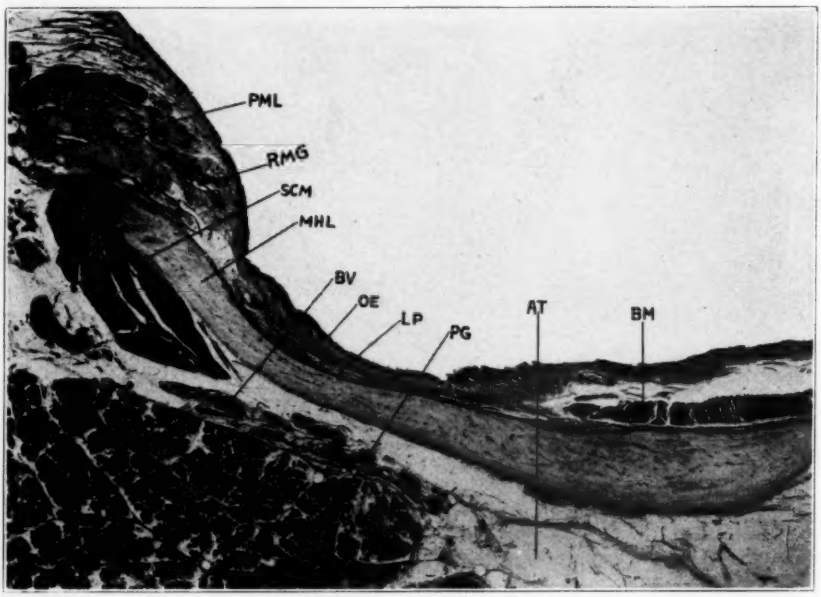


Fig. 13.—Sagittal section from posterior portion of lingual surface of edentulous lower jaw. *BM*, buccinator muscle; *AT*, areolar tissue; *PG*, pharyngeal glands; *LP*, lamina propria; *OE*, oral epithelium; *BV*, blood vessel; *MHL*, mylohyoid line; *SCM*, superior constrictor muscle; *RMG*, retromolar glands; *PML*, pterygomandibular ligament.

The region referred to in prosthetic parlance as the postdam area has but one

10. Kronfeld, Rudolf: Histopathology of Teeth and Surrounding Structures, Philadelphia: Lea and Febiger, 1933, p. 377.

rival as a factor of importance in the problem of denture retention: the "relief area." The postdam area occupies the region of the retromolar fossa at the crest of the alveolar ridge where the body joins is designated in the scheme of denture retention as the area of relief (Fig. 11). The anatomic relation of these two areas, both vulnerable factors in denture stability, creates an antagonist of the external

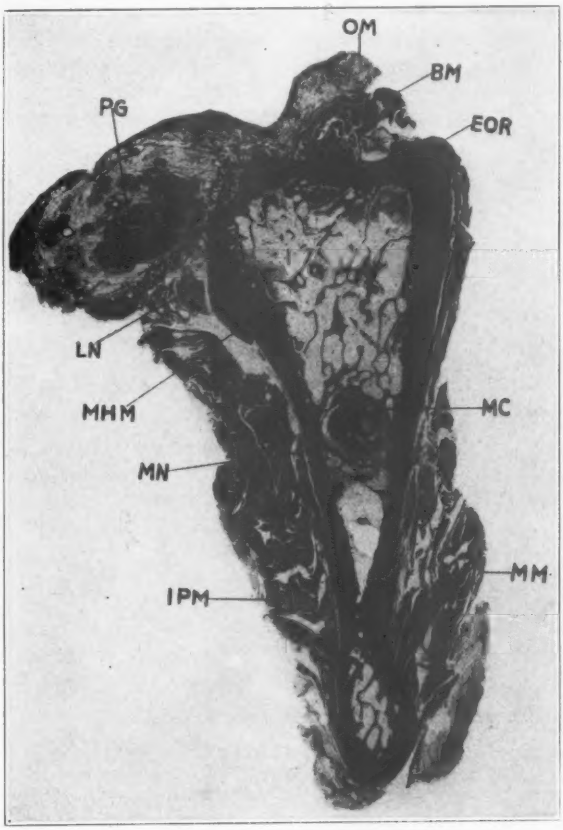


Fig. 14.—Frontal section at postmolar region of edentulous lower jaw. *OM,* oral mucosa; *PG,* pharyngeal glands; *LN,* lingual nerve; *MHM,* mylohyoid muscle; *MN,* mylohyoid nerve; *IPM,* internal pterygoid muscle; *MM,* masseter muscle; *MC,* mandibular canal; *EOR,* external oblique ridge; *BM,* buccinator muscle.

the ramus of the mandible. Its lateral boundaries are marked by the mylohyoid and the external oblique lines. It is the region of the external oblique ridge that oblique ridge that may defeat the purpose of the postdam.

The portion of the mandible that forms the floor of the retromolar fossa

presents a picture commonly unlike on the two sides of the jaw and which varies in different persons. It sometimes appears as a dense convex surface. In other instances, it is concave and porous. The buccal border of the floor is invariably smooth, hard and convex. The variations appear toward the lingual surface of the bone. The periosteum covering the floor of the retromolar fossa is usually thick, particularly at its buccal border. To the periosteum is attached a ribbon-like band of muscle fibers that extend from the cheek and are attached at the mylohyoid line of the mandible. Covering the musculature on the floor of the retromolar fossa are dense fibers of connective tissue that terminate at the anterior and posterior extremities as loose connective tissue. The dense central portion of these fibers forms a support for a small group of mucous glands. These retromolar glands, normally situated posteriorly to the mandibular third molar, form a part of the submucosa of the retromolar space. They are protected by a covering of dense fibrous connective tissue and epithelium, which is a part of the mucosa lining the oral cavity (Fig. 12).

At the posterior border, near the lingual wall of the retromolar region, is an eminence in the mucosa. In some persons, it is quite prominent and will be referred to as the retromolar papilla. Its structure is of loose connective tissue. It marks the posterior boundary of the glandular area and is directly above the attachments of a strong fasciculus of the superior con-

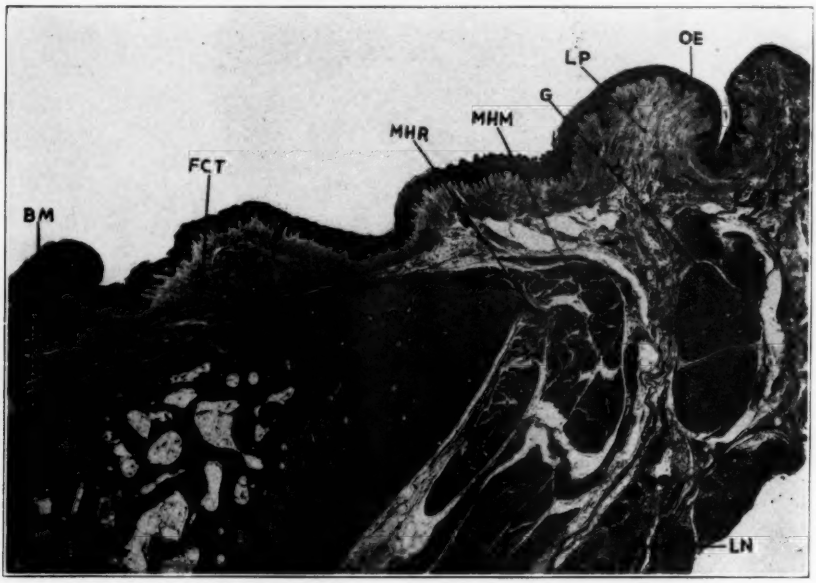


Fig. 15.—Frontal section at superior lingual surface in postmolar region of lower jaw. *BM,* buccinator muscle; *FCT,* fibrous connective tissue; *MHR,* spinous mylohyoid ridge; *MHM,* mylohyoid muscle; *G,* pharyngeal glands; *OE,* oral epithelium; *LCT,* loose connective tissue; *LN,* lingual nerve.

**Fig. 16.—Maxillary dentures showing distinctive forms of posterior palatal borders as produced by tongue action during impression taking. Above: Right: Upper jaw; low, broad tuberosities; long palate. Left: Upper jaw; long, broad hard palate; large right tuberosity. Center: Right: Upper jaw; left tuberosity broad and low; right tuberosity prominent. Left: Upper jaw; right tuberosity broad and low; left tuberosity prominent. Below: Right: Upper jaw; prominent tuberosities. Left: Upper jaw; short hard palate; prominent tuberosities; long, broad velum.**

strictor muscle at the mylohyoid line. It is here that the tendinous band of the pterygomandibular raphe, which separates the superior constrictor from the buccinator muscle, has its attachment to the mylohyoid line. The convergence of these muscular and tendinous attachments at this region of the denture area creates a physiologic action in the soft tissues that is an important factor in determining the form of the posterior border of the denture base (Fig. 13).

The relief area includes the posterior buccal border of the mandibular denture area. The structures of the lower jaw that compose this region are peculiar. The external oblique line of the mandible is the most dense and unalterable portion of the bone. To it is attached the strongest muscle of the cheek, the buccinator. Supporting the buccinator muscle is a large area of areolar tissue composed of connective tissue fibers, an abundance of fatty tissue and the mucous glands of the cheek. This pad of loose connective tissue creates the variable factor in taking the impression of this area and may either promote or disturb the equilibrium of the completed denture. If this region is compressed by the impression material, the beneficial influence of the postdam will be materially reduced (Fig. 14).

Of all the regions that are commonly injured by the wearing of artificial dentures, perhaps none is so abused as the mylohyoid fossa. This is the vestibule between the tongue and the lingual surface of the mandible at the posterior portion of the mylohyoid line. The most active evidence of tissue injury appears in mouths affected by atrophic processes in the bone. The form of the ridge of the mylohyoid line presents many variations and certain variations are the cause, in many cases, of failure in artificial denture construction. The soft tissues in the mylohyoid fossa are very elastic and highly vascular, with an abundant nerve supply. The coordinated action of the muscles of the tongue and pharynx promotes great activity of its structures.[11]

The structures constituting the mylohyoid fossa, like the other regions of the denture-bearing area, were studied from serial sections. Frontal plane series show the vertical fibers of the mylohyoid muscle and their attachment at the mylohyoid line. A bundle of nerve filaments (the lingual nerve) is separated from the fasciculus of the mylohyoid muscle by adipose tissue. The mucosa is composed of the oral epithelium and the lamina propria, a dense fibrous connective tissue that increases in thickness in the region of the residual ridge. The submucosa is formed by loose connective tissue fibers, fatty tissue and mucous glands (Fig. 15).

Sagittal sections of the mylohyoid fossa include the structures of the retromolar fossa together with the retromolar papilla, its submucosa of areolar tissue, its glands and the fasciculus of the superior constrictor muscle at the lingual surface of the mandible (Fig. 13).

Extremely important to the prosthetist is the pterygomandibular ligament, the fibers of which are seen at the posterior surface of the mylohyoid line. Below the line is a variable region with fatty and glandular tissues, blood vessels, nerves and muscle fibers, which constitute an elastic, highly sensitive and delicate area. At the crest of the mylohyoid ridge anteriorly to the retromolar fossa are the horizontal fibers of the buccinator muscle.

The vibrating action of the structures in this region presents a problem, demanding the most minute exactness in the design of the lingual flange of the mandibular denture base.

The clinical manifestations in the

11. Everett, G. E.: Impression Taking with Fluid Wax Compound, D. Sc. J. Australia, 11:299 (July) 1922.

structures in the various regions of denture support are elements of primary significance in denture prosthesis.

The problem of retention is one that has long been attended by elements of uncertainty, which prevail in methods of practice in obtaining impressions for complete dentures.

No method is more infallible than one based on the operator's knowledge of the structures of the jaws as portrayed by the clinical characteristics of the tissues.

The retention of complete dentures may be accomplished with the greatest degree of security only when the biologic factors are appraised with understanding.

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# CERTAIN PHYSICAL PROPERTIES OF ZINC PHOSPHATE CEMENTS

By F. A. PEYTON, Sc.D., and W. B. HOLMES, Ph.D., Ann Arbor, Mich.

DURING the forty or fifty years that zinc phosphate cements have been used in the practice of dentistry, nowhere has a comprehensive report been given on the influence of various factors in the manufacture and manipulation of the cement on the properties of the finished product. The early work of Ames,[1] Fleck,[2] Ward and McCormick,[3] Poetschke,[4] Crowell[5] and others adds to the story, but certain irregularities and inconsistencies become apparent when a correlation of all the results is attempted. It is only within the past year that a definite method has been adopted to measure the comparative properties of these materials. Work which has been carried on within the last three or four years has done much to remedy certain irregularities that apparently existed until that time.

Even now such factors as powder composition, temperature and time of firing the powder and liquid composition are not generally understood in their relation to the properties of the finished cement. The influence of certain of these factors seems to be known in a very general way, and perhaps more definitely so by certain manufacturers, who guard this information closely. The relationship of physical and mechanical treatment of the materials making up the cement to the properties of the finished product has certainly never been overemphasized in the literature dealing with this subject. For this reason, the dentist is often unable to determine in his own mind how he may handle a cement without harmful results.

This study was undertaken for the purpose of investigating the influence, on the physical properties of a zinc phosphate cement, of changing (1) the particle size of the cement powder, (2) the specific gravity of the cement liquid and (3) the composition of the cement liquid.

1. Ames, W. V-B.: J. Allied Societies, December, 1911.

2. Fleck, Herman: D. Items Int., 24:906 (Dec.) 1902.

3. Ward, M. L., and McCormick, R. M.: First Report of Study of Composition and Properties of Cements Now in Use in Dentistry, J.N.D.A., 2:354 (Nov.) 1915.

4. Poetschke, P.: Ind. Eng. Chem., 8:302, 1916.

5. Crowell, W. S.: Physical Chemistry of Dental Cements, J.A.D.A., 14:1030 (June) 1927.

POWDER COMPOSITION

In this study, only one powder was used. While it would be both interesting and advantageous to know the effect of systematically changing the powder composition, this seems to be a suitable subject for future study. In this investigation, it has seemed desirable to limit the powder to one composition for a better understanding of the influence of physical and mechanical variables on the powder as they affect the final physical properties of the cement. Preliminary studies showed that the powder composition, the firing temperatures and the time of firing of any given powder affect the properties of the powder to such an extent that a special study of these three variables as they relate to the properties of the finished cement will be necessary. These preliminary results are in keeping, in a general way, with the results of early investigations of Ward and McCormick,[3] Fleck[2] and Poetschke.[4] Recent improvements in testing methods and practices would make such a study most desirable.

The composition by weight of the powder adopted for this study was as follows: zinc oxide, 90 per cent; magnesium oxide, 9 per cent, and silicate, 1 per cent. Although we know that it is possible to compound a satisfactory powder containing various other ingredients, such as bismuth oxide, and barium compounds, it seemed desirable to use a powder of simpler composition for this study. A powder such as the one indicated represents about the average composition of a number of the cement powders on the market, as reported by the analysis of Paffenbarger, Sweeney and Isaacs.[6]

The details of the condition of the raw materials and the firing times and temperatures, as well as the compounding procedure with this powder, will not be given, since the purpose of this paper does not indicate the need for a discussion of these variables. It will suffice to say that the powder was compounded and treated in a manner entirely in keeping with good manufacturing practice for such powders. The crude stock material used for the grinding experiments which will be described presently was crushed in a jaw crusher from a hard clinker to such fineness that 70 to 80 per cent passed 100-mesh screens. This served as a source of the crude, unfinished cement powder.

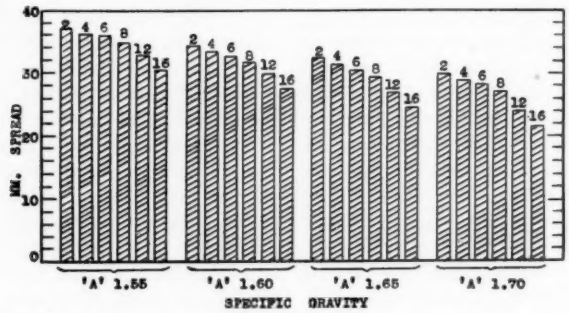


Fig. 1.—Influence of grinding time in hours on millimeter spread (consistency) of cement powder when liquid of four different specific gravities is used.

6. Paffenbarger, G. C.; Sweeney, W. T., and Isaacs, Aaron: Preliminary Report on Zinc Phosphate Cements, J.A.D.A., 20:1960 (Nov.) 1933.

The finish grinding of the powder was done in a ball mill consisting of a 6 by 6 inch, inside dimensions, Knight Chemical Stoneware jar, with approximately 6 pounds of three-quarter uniform flint glass balls. The mill was operated at a speed of 58 r.p.m. For this mill, a 2-pound charge of the crude stock mentioned above was used.

Since it was intended systematically to study the grinding over a period of several hours, it seemed desirable to adopt two, four, six, eight, twelve and sixteen hours as representative times for grinding. From some preliminary experiments with the same apparatus and a similar powder, it was thought that eight hours would probably be about the correct grinding time. This was found to be true as is shown by data presented later. In the case of the twelve and sixteen hour lots, the mill was stopped after eight hours and all the powder was brushed from the sides of the jar and balls. This prevented caking in the mill. It was observed that there was a slight yellow tinge in the lots ground for twelve and sixteen hours, which was not evident in the lots ground for a shorter time. This probably was the result of the fact that reduced particle size produced a different shade. After the grinding was finished, each lot was passed through a 100-mesh sieve to break up any agglomerates of dry powder before using. No further treatment was given to the powder.

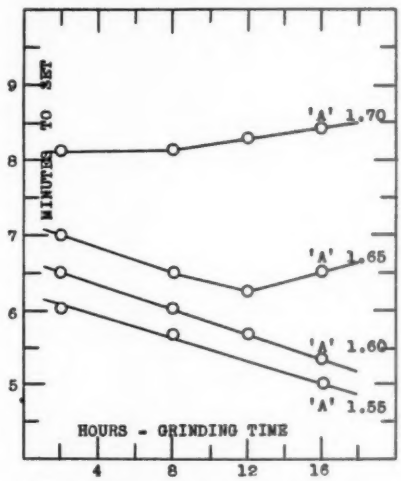


Fig. 2.—Relationship of grinding time (particle size) to setting time in minutes at mouth temperature and saturated humidity, liquid of four different specific gravities being used.

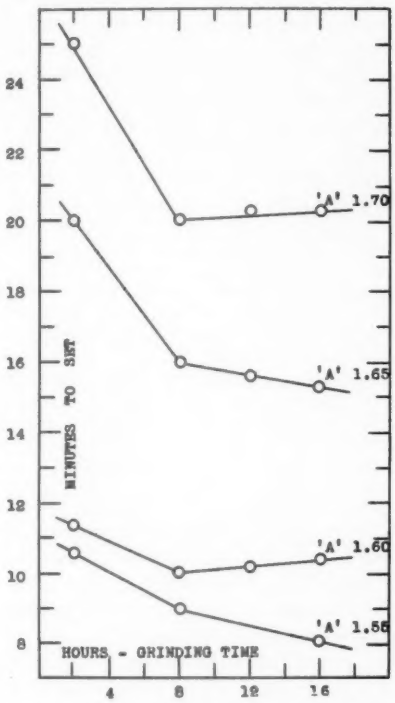


Fig. 3.—Relationship of grinding time (particle size) to setting time in minutes at room temperature, liquid of four different specific gravities being used.

LIQUID COMPOSITION

There has been little information presented in the literature concerning the influence of changing any of the variables associated with zinc phosphate cement liquids. Nothing has been given concerning the reason for or the results of the variation in composition of the cement liquids on the market, since such influences are not evident until a series of liquids are studied with one powder. Paffenbarger, Sweeney and Isaacs[7] have observed that considerable variation exists in the specific gravity of the liquids of the various cements on the market, but have made no comments concerning the reason for or the results of this variation. They did observe at an earlier time[6] that a 10 per cent dilution, or a lowering of the specific gravity, modified the setting time for several cements. This tends to point out the lack of information in the literature concerning the fundamental properties of dental cement liquids.

TABLE 1.—COMPOSITION OF "A" LIQUID AT DIFFERENT SPECIFIC GRAVITIES

| Specific Gravity | Dilution Per Cent | Aluminum Per Cent by Weight | Zinc Per Cent by Weight |
|---|---|---|---|
| 1.65 | .... | 2.8 | 4.7 |
| 1.60 | 10.1 | 2.6 | 4.4 |
| 1.55 | 20.1 | 2.4 | 4.1 |

Crowell has pointed out by means of physicochemical studies that, in order to obtain a completed reaction between phosphorus pentoxide, water and zinc oxide, a liquid of only one definite composition may be used. While this study is interesting and instructive, it fails to make clear the range of properties of the finished cement that may be expected by varying the composition and specific gravity of the liquid for a zinc phosphate cement.

Manufacturers of dental cements have offered little information of a definite nature on this subject. Each manufacturer advises the use of only the one liquid specified for the particular brand of powder, if the dentist would expect the best results from his cement. No manufacturer seems to be very definite in pointing out quantitatively the precise reasons for having adopted one specific liquid composition in preference to all others.

TABLE 2.—RESULTS OF TESTS FOR CONSISTENCY OF MIX

| Grinding Hours | Liquid "A" | Powder:Liquid Ratio | Spread Mm. |
|---|---|---|---|
| 2 | 1.55 | 13:5 | 38− |
| 2 | 1.60 | 13:5 | 34+ |
| 2 | 1.65 | 13:5 | 32+ |
| 2 | 1.70 | 13:5 | 30 |
| 4 | 1.55 | 13:5 | 37− |
| 4 | 1.60 | 13:5 | 34− |
| 4 | 1.65 | 13:5 | 31+ |
| 4 | 1.70 | 13:5 | 29 |
| 6 | 1.55 | 13:5 | 37− |
| 6 | 1.60 | 13:5 | 33 |
| 6 | 1.65 | 13:5 | 31− |
| 6 | 1.70 | 13:5 | 28+ |
| 8 | 1.55 | 13:5 | 35 |
| 8 | 1.60 | 13:5 | 32 |
| 8 | 1.65 | 13:5 | 29+ |
| 8 | 1.70 | 13:5 | 27 |
| 12 | 1.55 | 13:5 | 33 |
| 12 | 1.60 | 13:5 | 30 |
| 12 | 1.65 | 13:5 | 27 |
| 12 | 1.70 | 13:5 | 24 |
| 16 | 1.55 | 13:5 | 30+ |
| 16 | 1.60 | 13:5 | 28− |
| 16 | 1.65 | 13:5 | 24+ |
| 16 | 1.70 | 13:5 | 21+ |

7. Paffenbarger, G. C.; Sweeney, W. T., and Isaacs, Aaron: Zinc Phosphate Cements: Physical Properties and Specification, J.A.D.A., 21:1907 (Nov.) 1934.

Poetschke has noted that the specific gravity of the liquid alters the crushing strength values of silicate cements, and suggests that only one liquid can be expected to produce the best results with a given powder. He has not shown how changing the specific gravity influences the various properties of zinc phosphate cements.

The liquid used in this study, the purpose of which was to observe the influence of changing the specific gravity, contained both zinc and aluminum as modifying agents. The composition of this liquid at three different specific gravities is given in Table 1. The specific gravities were all determined at 70 F. Since these values represent calculations made from known quantities and weights of materials used to make up the liquid, they probably represent accurate values to within ±0.2 per cent by weight of the average values indicated. By observing the amount of water necessary to change a given quantity of the liquid from one specific gravity to another, it was possible to calculate the percentage dilution. This is also given in Table 1. The specific gravities used on this liquid approximate the average range of values of liquids on the market used for zinc phosphate cements, according to the report of Paffenbarger, Sweeney and Isaacs.[7]

Table 3.—Data on Crushing Resistance

| Grinding Hours | Liquid "A" | Powder: Liquid Ratio | Spread Mm. | Particle Size Microns | Minutes to Set 99 F. | Minutes to Set Air | Film Thickness Microns | U.C.S. Lb. per Square Inch 1 Hour | U.C.S. Lb. per Square Inch 1 Week |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 1.65 | 14:5 | 29+ | 71 | 7 | 20 | 45 | 9,500 | 12,100 |
| 8 | 1.65 | 13:5 | 29+ | 52 | 6+ | 16 | 32 | 10,400 | 12,700 |
| 16 | 1.65 | 11:5 | 30 | 36 | 6+ | 15 | 30 | 9,000 | 11,400 |

Table 4.—Influence of Variation in Specific Gravity on Consistency

| Grinding Hours | Liquid "A" | Powder: Liquid Ratio | Spread Mm. | Particle Size Microns | Minutes to Set 99 F. | Minutes to Set Air | Film Thickness Microns | U.C.S. Lb. per Square Inch 1 Hour | U.C.S. Lb. per Square Inch 1 Week |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 1.55 | 16:5 | 29− | 71 | 6 | 10+ | .. | 8,600 | 10,250 |
| 2 | 1.60 | 15:5 | 30− | 71 | 6+ | 11+ | 45 | 9,900 | 12,100 |
| 2 | 1.65 | 14:5 | 29+ | 71 | 7 | 20 | 45 | 9,500 | 12,100 |
| 2 | 1.70 | 13:5 | 30 | 71 | 8+ | 25 | 45 | 8,900 | 11,100 |
| 8 | 1.55 | 15:5 | 29+ | 53 | 5+ | 9 | 35 | 9,300 | 12,850 |
| 8 | 1.60 | 14:5 | 30+ | 53 | 6 | 10 | 37 | 10,200 | 12,400 |
| 8 | 1.65 | 13:5 | 29+ | 53 | 6+ | 16 | 32 | 10,400 | 12,700 |
| 8 | 1.70 | 12:5 | 29+ | 53 | 8+ | 20 | 32 | 8,600 | 10,800 |
| 16 | 1.55 | 13:5 | 30+ | 37 | 5 | 8 | 35 | 8,500 | 12,400 |
| 16 | 1.60 | 12:5 | 30+ | 37 | 5+ | 10+ | 30 | 11,100 | 12,300 |
| 16 | 1.65 | 11:5 | 30 | 37 | 6+ | 15+ | 30 | 9,000 | 11,400 |
| 16 | 1.70 | 10:5 | 30+ | 37 | 9 | 20+ | .. | 8,700 | 10,900 |

## RESULTS

Tests for consistency of the mix were performed by the method described in the A.D.A. Specification No. 8.[8] Results of these tests are given in Table 2.

8. Footnote 7, p. 1921.

All values in this table were determined at a room temperature of 70 degrees ±2 F., and all of these consistency tests with each liquid were made within a period of a few hours on the same day. These data represent the influence both of grinding time on the powder and of changing the specific gravity of the liquid, liquid "A" being used at four different specific gravities for each grinding time. Six different grinding times are indicated.

Table 5.—Composition of Various Liquids

| Liquid (1.65 Specific Gravity) | Aluminum Per Cent by Weight | Zinc Per Cent by Weight |
|---|---|---|
| A | 2.8 | 4.7 |
| B | 2.8 | 6.0 |
| C | 3.1 | 4.7 |
| D | 3.1 | 6.0 |
| T | 2.9 | ... |
| M | 3.1 | ... |
| N | 1.6 | 7.6 |

Table 6.—Results of Using "A" 1.65 and Grinding Eight Hours

| Powder: Liquid Ratio | Spread Mm. | Particle Size Microns | Minutes to Set 99 F. | Minutes to Set Air | Film Thickness Microns | U.C.S. Lb. per Square Inch 1 Hour | U.C.S. Lb. per Square Inch 1 Week |
|---|---|---|---|---|---|---|---|
| 13:5 | 29+ | 53 | 6+ | 16 | 32 | 10,400 | 12,700 |
| 13:5 | 31 | 53 | 6+ | 15 | .. | 10,950 | 10,500 |
| 12:5 | 31− | 53 | 7 | 18 | .. | 9,200 | 11,700 |
| 13:5 | 29+ | 53 | 6 | 14+ | 27 | 10,200 | 9,700 |
| 115:5 | 30− | 53 | 12+ | 30 | 27 | 8,200 | 12,000 |
| 115:5 | 31− | 53 | 9 | 25 | .. | 8,600 | 10,700 |
| 15:5 | 29 | 53 | 5 | 10+ | 27 | 7,400 | 7,300 |

It was desirable to study the different amount of spread of the disk when using a constant powder:liquid ratio for all determinations. These data have shown that, regardless of the grinding time, whether it be two hours or sixteen hours, there is a difference of from 8 to 9 mm. spread between a liquid of 1.55 specific gravity and one of 1.70 specific gravity when the same quantity of powder and liquid is used. It will be shown later (Table 4) that this represents 0.3 gm. of powder for each grinding time, when a constant volume of liquid is used to produce a uniform spread of 30 mm., as required for the A.D.A. Specification.

Table 2 also shows that for the extremes in grinding times, when using a liquid of one specific gravity, as, for example, 1.55, or 1.70, there is a difference of from 7 to 9 mm. in the spread of the disk when a constant ratio is maintained. This again represents a maximum difference of 0.3 gm. of powder to produce a uniform spread of 30 mm. It can readily be seen, therefore, that great differences in consistencies will probably occur in commercial cements, even though the chemical composition and firing treatment of the powders might be the same. In Table 2, there is shown to be a maximum difference between a coarsely ground powder with a low specific gravity liquid, and a more finely ground powder with a high specific gravity

Table 7.—Influence of Temperature on Film Thickness

| Temperature F. | Powder Hours | Liquid "A" | Powder: Liquid Ratio | Thickness Microns |
|---|---|---|---|---|
| 65 | 8 | 1.65 | 13:5 | 30 |
| 70 | 8 | 1.65 | 13:5 | 32 |
| 79 | 8 | 1.65 | 13:5 | 40 |
| 88 | 8 | 1.65 | 13:5 | 47 |

liquid of 16 or 17 mm. spread when the same powder:liquid ratio is used. This represents a difference equal to 40 to 50 per cent in the spread of the disk. When changed to produce a uniform spread for both extremes, there is a difference of 0.6 gm. of powder needed to satisfy 0.5 c.c. liquid, to produce a 30 mm. disk.

Figure 1 presents graphically the data given in Table 2. It is interesting to observe, from Figure 1, that, with all four specific gravities, the spread of the two-hour sample was 30 mm. or more when a ratio of 1.3:0.5 was used; while, with the 16-hour sample, all values were less than 30 mm. spread, the same ratio being used. The same may be said of liquids 1.55 and 1.70, respectively, when all six powders were used. In addition, it may be seen that there is a similarity between the groups shown, with a regular decrease in values as the specific gravity of the liquid is increased.

In addition to the observations already pointed out, there were a few general observations made during the testing of the consistencies which influenced the choice of specific gravity for the tests that are to follow. Among other things, it was observed that in all mixes made with "A" 1.55 there was a lack of "body" in the freshly mixed cement. This may be better characterized as a "watery" mix. A tendency toward this same phenomenon has been generally observed whenever a liquid of less than 1.60 specific gravity is used with any powder. The mix is easy to manipulate with the low specific gravity liquid, but there is always the tendency for the spatula to break through the cement film on the mixing slab during spatulation, much the same as if water were being used to mix with the powder.

On the other hand, when using "A" 1.70, the liquid had a smooth, velvety feel under the spatula when the powder which had been ground for two or four hours was used. This seems characteristic of heavy liquids. When the powder was ground for a longer time, there was a tendency toward a granular or gritty mix, this tendency increasing with increased grinding time. Liquids "A" 1.60 and "A" 1.65 both gave good, smooth mixes, not varying far from a 30 mm. average spread when a 1.3:0.5 ratio was used, even for extremes in grinding. The only choice between the two liquids was in the general appearance of the mix of "A" 1.65, which was slightly smoother and less "watery" for all powders than "A" 1.60.

The next step was to determine several properties, according to methods of A.D.A. specification testing, of a cement mixed from representative grinding times on the powder and using liquid "A" 1.65. Values for these determinations are given in Table 3, which shows that there is a decrease in the powder:liquid ratio of 0.3 gm. per 0.5 c.c. liquid to produce a uniform disk of 30 mm. In other words, the finer the powder in a dental cement, the less powder needed to satisfy a given quantity of liquid of a definite composition.

The gradual reduction of particle size with continued grinding time is also shown in Table 3. It may be seen that, in fourteen hours, there is approximately a 50 per cent reduction in the particle size when the powder is ground as already described. These measurements of maximum particle size were made by the method described by Paffenbarger, Sweeney and Isaacs,[6] the usual precautions being observed.

One of the most interesting observations listed in Table 3 is the fact that the setting time of the cement, when measured at mouth temperature and saturated humidity, seems to be practically unaffected by change in the particle size of

the cement powder when this particular liquid is used. This is not what might at first be expected, but is probably accounted for by the fact that the powder: liquid ratio is changed sufficiently to offset any difference that may arise from increased reactivity due to smaller particles of powder. When tested at room temperature, there is a difference of a few minutes in the setting time between finely and coarsely ground powders. This table indicates that setting time does not control the consistency of the mix, as is sometimes thought, but rather that the consistency ratio tends to control the setting time to some extent.

The relationship of film thickness to particle size is also indicated in Table 3. While there is a reduction in film thickness as the particle size is reduced, there does not seem to be a uniform relationship between the two. Additional work on this phase of the study is indicated from these results. It would be particularly interesting to determine how a further reduction in particle size would affect the film thickness. Head[9] has made numerous tests on film thickness of cements, showing that the film thickness does decrease as the particle size becomes smaller, but he has not expressed this relationship quantitatively. Results of tests on the crushing resistance (Table 3) indicate that there is no pronounced influence beyond experimental error of particle size alteration on crushing strength when one liquid of average specific gravity is used.

Table 4 presents results of tests made to show how the specific gravity of the liquid influences the consistency ratio, with different grinding times on the powder. It also shows how the setting time is prolonged slightly with increased specific gravity of the liquid for each grinding time. This agrees in general with the results of other investigations. In this table, there seems to be no pronounced regularity in the relationship of grinding time to setting time, except as the liquid is changed. The average crushing resistance with all liquids on the eight-hour grind is slightly above that on either shorter or longer grinding periods when tested after seven days. The four, six and twelve hour grinding times were not all tested because, as seen in Table 4, for some properties the variation in values between those powders tested is very slight, so that there would be an overlapping of results if all the powders were included.

There are possibly two distinctly different reasons for the decrease in crushing strength of samples ground for a two hour period and those ground for a sixteen hour period. It seems that perhaps with the two hour grind, the ratio of powder to liquid is excessively large, so that complete reaction does not occur with the measured amount of liquid used. This condition may exist because of the fact that large powder particles present less surface to be wetted by the liquid in the early stages of the mix. Likewise, they react more slowly than small particles with the cement liquid. More powder will therefore be required to produce the same consistency. As the chemical reaction between powder and liquid proceeds, the powder is found to be in an excess greater than normal at the end of the mix; which results in an unbalanced completed reaction, thus producing a cement of slightly weakened crushing strength. A situation approximating a "starved" mix with respect to the amount of liquid that it contains is considered to exist in the final set mass of cement. Especially is this indicated with liquid "A" 1.55 and the powder ground

9. Head, Joseph: Modern Dentistry, Ed. 2, Chap. XI, Philadelphia: W. B. Saunders Co., 1920.

for two hours. The same situation is suspected in the case of some of the cements on the market which have large particles and light liquids.

The opposite condition exists with the powder ground for sixteen hours. With the fine powder, there is more surface to be wetted by the given amount of liquid than in the case of the powder ground for two hours. As seen by the setting time at room temperature, the chemical reaction is likewise, normally, more rapid in this case. Consequently, it will require the use of less powder per given quantity of liquid to produce the same consistency. This, then, may be reflected in the crushing tests by producing a cement, especially with heavier liquid combinations, in which the liquid is not so completely satisfied with powder. A weakened crushing strength test sample accordingly results. In this case, the cement mass may be considered as "starved" with respect to the amount of powder that it contains.

The statement by Crowell[5] that "if a large amount of water is present in the liquid, an excessive amount of free water will remain after the $ZnHPO_4.3H_2O$ has crystallized, weakening the hardened cement" appears to hold only in case a constant consistency ratio or an abnormally diluted liquid is used to make the mix. The cement does not seem to be weakened by the use of a diluted liquid (compare "A" 1.55 and "A" 1.70) when the powder has been properly ground to satisfy the liquid. A summary of these data on crushing strength for seven-day tests indicates that the two-hour grind with "A" 1.55 liquid is lower than average; that all grinding times with liquid "A" 1.70 are lower than average, and that there is an indication of a general tendency toward a decrease in crushing strength with an increase in specific gravity of the liquid, when any one powder is used. The remainder of the data are close enough to be within experimental error.

Figures 2 and 3 represent the data given in Table 4 for setting time variations according to grinding time of the powder and specific gravity of the liquid. Figure 2 represents values at mouth temperature and Figure 3 at 70 F. in air. While the actual values are sufficiently close in some cases in Figure 2 to be considered within experimental error, duplicate tests showed that the faster setting combinations did not vary more than ten to fifteen seconds maximum in most cases. The data are presented here only to show that they may have some significance in indicating typical behavior of powders and liquids. As the particle size becomes smaller, at mouth temperature there is a gradual shortening of setting time with the lower specific gravity liquids. This is what would be expected. With the heavier liquids, this effect seems to be lost. As is seen with liquids "A" 1.65 and "A" 1.70, powders of all grinding times set at approximately eight minutes. A somewhat similar situation is observed in Figure 3, when the cement was allowed to set at room temperatures. In this case, with each liquid, the setting time was practically unchanged after the powder had been ground for eight hours or more. For the two-hour grind, the setting time was prolonged somewhat with each liquid.

It is shown in Table 4 that, for a finely-ground powder, a low specific gravity liquid is needed to produce a high powder:liquid ratio. This is also shown in the report of Paffenbarger, Sweeney and Isaacs.[7] These facts may be observed in their report by considering values of their Table 1 and Table 2 and noting that, for all the powders below 50 microns, the cements having the greatest powder:liquid ratios also have

low specific gravity liquids. These facts should help to explain some of the great variations in the consistencies that were observed by these authors. There is some further value to these observations when it is noted, as already pointed out, that the consistencies of the cement have a general relationship to some of its other physical properties. In the report of Paffenbarger, Sweeney and Isaacs,[7] no cement with a powder:liquid ratio below 8:5 gave values for other physical properties sufficient to meet the A.D.A. Specification. It may also be observed, from their work, that two of the cements tested, "O" and "P," had high ratios but, at the same time, did not meet the specification. It is thought that possibly this may be traced partly to the fact that the particle size of these powders, "O" and "P," was extremely large and that in the case of cement "P," the specific gravity of the liquid was very low, and partly influenced by the composition and treatment of the powder. It has already been pointed out in this report that in the case of tests made with coarse powders and light liquids, the powder: liquid ratio may be high and, at the same time, give low grade physical properties. There seem to be no cases in which cements with low consistency ratios give high grade physical properties.

The point to be made at this time is that the powder:liquid ratio necessary to assure uniform consistency does have considerable bearing on the other physical properties of the cement. It may be said, in general, that in order to assure more uniformly high-valued powder:liquid ratios in cements, the finely ground powders should have low specific gravity liquids and the coarsely ground powders should have heavier liquids, within limits. Not only does this give better consistency values, but it also produces a cement that mixes more easily. Granular and gritty mixes result less often when a light liquid is used with a fine powder. Coarser powders naturally will accommodate heavier liquids without difficulty.

In connection with what has already been said regarding the consistency of cements as related to light liquids for fine powders, it should be observed that the liquid composition also has considerable influence on these values. If a liquid is definitely unbalanced with modifying agents, as is liquid "N" in Table 5, the consistency alone will not give the cement superior physical properties. This liquid is adapted to certain types of powder, but not so well as liquids "A," "B," etc., to the powder investigated.

The composition of seven different liquids used in connection with this powder are given in Table 5. Liquids "A," "B," "C" and "D" represent closely related liquids made by varying slightly, in a systematic manner, the aluminum and zinc components. Liquids "T" and "M" were made without zinc and have a slightly different aluminum content. Liquid "N" represents one to which aluminum with an excess of zinc has been added.

The results of using these liquids, all of one specific gravity, with the powder ground for eight hours, are given in Table 6. It will be noticed that there is an agreement of results between liquids "A," "B," "C" and "D." An excess of aluminum in liquid "C" seems to have lowered the consistency ratio and retarded the setting time slightly. The values for crushing resistance appear to be better when using liquid "A" than with the others. Liquids "T" and "M" likewise show a similarity in some of their physical properties. The consistency ratios with these liquids are much lower than with the first four liquids studied. Their setting times are also retarded considerably. The crushing resistance, after

one hour, likewise appears somewhat reduced from that of the four above. After seven days, the crushing resistance has increased to a point where it compares favorably with the average of the foregoing tests. Liquid "N," with its high zinc and reduced aluminum content, has a very high consistency ratio and set rapidly, but also has low crushing resistance both at one hour and after seven days. These results agree with the discussion already given concerning either an unbalanced liquid or a mix that has powder in excess of the amount necessary to satisfy the free acid of the liquid, but does not give the most desirable physical properties. This table presents sufficient data to show that an extended study of the physical properties of dental cements as influenced by the composition of the liquid would be extremely desirable. It appears that each powder requires a liquid of definite composition and specific gravity to obtain the maximum physical properties and to produce a "balanced" cement. Nevertheless, certain limits in the range of composition might be well established by further study.

It has been observed in this study that the film thickness of cements is influenced very appreciably by the temperature of the mix and the room temperature at the time of measurement of film thickness. Values for some observations are given in Table 7. Measurements were made according to methods described by the A.D.A. Specification, with a probable error of $\pm 2.5$ microns. These data are entirely preliminary to a prolonged study of the relationship of film thickness to other physical properties, which should be of considerable practical significance. It will be seen that when a given powder and one given liquid, with a constant consistency ratio, are used, there is a 17-micron difference in thickness for a temperature difference of 23 F. It is known from other tests that the temperature of the mix has a great influence on the setting time when the mix is allowed to set at the temperature of the mix. As temperature also influences the consistency ratio, it would be interesting to see the results of tests made from mixes when a constant spread is maintained.

The values presented in Table 7, although brief, have considerable clinical significance. As stated, these tests were all made in air at room temperature, at one constant ratio. These tests parallel, therefore, to some extent, the practices of the dentist. For example, if given one powder : liquid ratio by the manufacturer as the correct one to follow, the dentist perhaps would not change this value from summer to winter, when the temperature in his office may vary from 20 to 30 degrees F. In order to avoid uncertainty concerning the other properties of the cement, he would possibly continue in the summer to use the same ratio that had worked satisfactorily during the winter when the temperature was from 65 to 70 degrees. The mix made in summer at 90 F. or more is put into a tooth at the same temperature as the mix made during the winter, when the room temperature was lower. While this temperature difference may not affect the setting time or the crushing resistance of the cement if both mixes are allowed to set at mouth temperature, it will change the consistency of the mix and will probably alter the film thickness to a considerable extent. It has already been stated that these properties will all be modified by the various properties of the powder and liquid. These facts are significant in pointing out that numerous factors are to be given consideration in judging the quality of dental cements.

It is recognized that the data presented in this report are preliminary to an extensive study that can be made of this

subject to show more conclusively a number of the properties here suggested for zinc phosphate cements. The data have been presented with the hope that they may aid in suggesting solutions relating to some of the dental cement problems.

SUMMARY

1. All the properties of a cement should be given consideration in judging its qualities rather than concentrating on a few of the properties, perhaps at the expense of others that may be equally important. Further work on certain properties should prove to be of considerable value.

2. The powder:liquid ratio necessary to produce a constant consistency is decreased as the specific gravity of the liquid is increased.

3. The length of setting time is prolonged as the specific gravity of the liquid is increased. This has been observed generally in other investigations.

4. An increase in the specific gravity of the liquid within limits produces a slight decrease in the crushing resistance.

5. A decrease in the consistency of the mix occurs as the particle size of the powder is decreased when a constant powder:liquid ratio is used.

6. As the particle size of the powder is decreased, the setting time of the cement remains practically constant with liquids of average specific gravity or above. The use of low specific gravity liquids produces cements that set slightly faster with a decrease in particle size. These results are probably influenced somewhat by the different powder:liquid ratios necessary to produce uniform consistency for each particle size and specific gravity combination.

7. A decrease in film thickness occurs as the particle size of the powder is decreased, although the decrease is not uniform with particle size reduction.

8. If the particle size of the powder is too large or too small, the crushing strength decreases slightly, unless properly adjusted liquids are used.

9. The powder:liquid ratio necessary to produce a constant consistency is modified by changing the liquid composition.

10. The setting time of the cement is altered to a considerable degree by changing the liquid composition.

11. Throughout the range studied, a change in the liquid composition changes the crushing resistance of the cement.

12. When a constant powder:liquid ratio is used, the film thickness is greatly affected by the temperature of the room at the time of the test.

## LOCALIZATION OF A BROKEN NEEDLE IN THE MAXILLARY REGION

By ALBERT J. WHITFIELD, D.D.S., San Francisco, Calif.

THE breaking of a hypodermic needle in making an injection is not uncommon in dental practice. When a needle is broken in the oral cavity, and lost, the first step in planning its successful recovery is localization. There has been much written on the localization and removal of needles from the deep tissue areas of the internal surface of the mandibular ramus, but little on those broken and lost in the maxillary region.

The technic described for this pro-

cedure, which was perfected by me, with the assistance of Leonard Frank, a dental radiographer, has proved simple and effective in the many cases wherein it has been employed.

Description is obtained of the type, length and gage of the broken needle fragment and its approximate point of insertion. Four roentgenograms are required. These are depicted in Figures 1-4, two views without the guide needles and two with it in position.

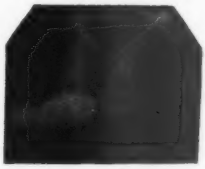

Fig. 1.—Lost needle fragment high up in mucobuccal fold, opposite apical third of left maxillary third molar.

Fig. 2.—Occlusal view showing the broken needle to be about 3 mm. externally from maxillary tuberosity.

Figure 1, a dental film placed parallel to the long axis of the maxillary teeth, will verify the data obtained.

Figure 2, which is known as an occlusal view, is a large film placed in the mouth at right angles to the long axis of the maxillary teeth. The roentgen rays are directed from above the head downward. This view will give the relative position of the broken needle as to the alveolar ridge of the maxilla.

After these two procedures, the operator will gain a mental picture of the approximate position of the lost fragment, and the anatomic landmarks of the site. A guide needle, with some type of guard, is then inserted as close to the lost fragment as possible, care being taken not to strike and drive it farther into the tissues.

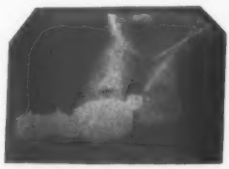

Fig. 3.—Guide needle crossing lost fragment at an angle.

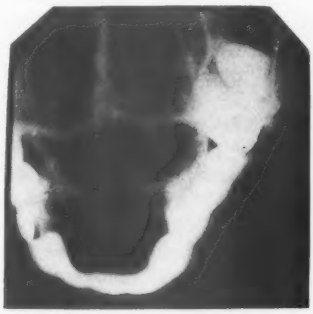

Fig. 4.—Guide slightly internal to broken needle fragment.

Figures 3 and 4 show the guide needle in position.

Figure 3 is a lateral view taken on a dental film, and, in this particular case, the guide needle is shown crossing the lost fragment at an angle. Information gained from this film will aid the operator in planning the initial incision.

Figure 4, an occlusal view similar to the one in Figure 2, will definitely estab-

lish the position of the broken needle fragment, either internally or externally to the guide. The knowledge gained from this view is very important to the operator in directing the line of incision and for a successful recovery.

This method of localization as described will preclude a great deal of unnecessary dissection and searching on the part of the operator, and will act as a positive aid in the definite recovery of any broken needle fragment in the maxillary region.

450 Sutter Street.

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# THE CAST-ALUMINUM BASE DENTURE*

By DAYTON DUNBAR CAMPBELL, D.D.S., Kansas City, Mo.

IN the development of aluminum alloys for airplane and highspeed train construction, the Aluminum Company of America gave to the professions a fund of information about the chemical, electrical and physical characteristics of aluminum and its alloys that is equaled only by the work of the Bureau of Standards at Washington for the commercial industries.

The results of these commercial researches and studies, together with laboratory experiments and practical demonstrations, are set forth in a large number of papers, pamphlets and booklets, which may be secured gratis by addressing the Aluminum Research Laboratories, Aluminum Company of America, New Kensington, Pa. I acknowledge my indebtedness to these authors, many of whom it has been my good fortune to meet and whose cooperative spirit has encouraged me to make further demands on their time.

Except for the unique method of casting aluminum in a cowbell (subsequent to Dr. Taggart's development of the cast gold inlay in 1907) and adapting the new (?) aluminum magnesium and aluminum silicon alloys to dental uses, there is little original in this paper. The footnotes will show how freely I have lifted terminology, phraseology and even paragraphs in order to give a more comprehensive understanding of the marvelous qualities possessed by these newer alloys —new, at least, to dentistry.

In this discussion of the dental possibilities of aluminum and its alloys, I seek to bring to my confrères the first fruits of my findings.

The announcement of the miraculous discovery of a new aluminum alloy that was parading under a "highfalutin" name would make unnecessary inroads on the already depleted budgets of dentists. A variety of alloys of aluminum are now available for dental castings. Only the aluminum magnesium alloy will be considered. Luckily, there is no ponderous equipment needed to cast dental bases, nor is any ingredient of the alloy secret. No phase of its manufacture or subsequent treatment is shrouded in mystery.

For years, I steadfastly refused to use an alloyed aluminum, because, early in my experience, I was chagrined to have an occasional patient return with holes in

*Read before the Section on Full Denture Prosthesis at the Seventy-Seventh Annual Session of the American Dental Association, New Orleans, La., Nov. 5, 1935.

the aluminum base. This was found to be caused by impurities of iron and silicon in the metal, which later, in the fluids of the mouth, caused a disintegration owing to the galvanic action of the highly electropositive aluminum in contact with the negative intruding iron or silicon. Iron and silicon are both used now as an aluminum alloy, but they are held in solid solution.[1]

R. Frank Denny, of Indianapolis, Ind., encouraged by some experiments in aluminum alloys, induced me to try an alloy of magnesium and aluminum, designated by the producers as Alcoa No. 214. A few castings of this alloy demonstrated immediately that our technic could be shortened. Where formerly 99.7 pure aluminum was used, which necessitated swaging upon the original master model, we were gratified to find that this alloy No. 214 (aluminum-magnesium 3.75) had a melting point 96.25 degrees below pure aluminum (1260 F.) and shrinkage or distortion so slight that subsequent swaging becomes unnecessary. The castings finish harder, and resistance to lateral stress increases about five times that of pure aluminum; all of which makes it the outstanding metal for denture bases now in use. It is superior to platinum, gold, silver, steel or their respective alloys. I invite attention to five reasons for the foregoing statements:

1. Aluminum is the only self-cleansing denture base material.

2. Aluminum (all other factors remaining constant) ranks highest among the usable metals.

3. Aluminum may be permanently dyed the hue or color closely approximating that of gum tissue.

4. Aluminum is the least expensive of all denture base metals.

5. Aluminum denture base construction presents no greater difficulties than the cast gold inlay.

Let us consider these statements in order:

1. Aluminum is the only self-cleansing denture base material. If a piece of aluminum is abraded or scratched, an oxide coating or film immediately forms upon the surface, which, for the moment, may be only a wave length of light in thickness, but which progressively thickens until it becomes self-limiting. Aluminum oxide itself is white. When the teeth are to be attached to an aluminum base with vulcanite, the sulphur in the rubber combines with this oxide coating to darken the metal surface to such an extent that it is necessary to use a warm solution of sodium-hydroxide (caustic soda) to remove it. The denture is then washed in water before insertion in the mouth. A very attenuated alkaline solution, such as we know the saliva to be normally, acts mildly and constantly on the aluminum base dentures, preventing any accretions; which entitles us to call the base self-cleansing.

One has only to examine any aluminum base denture to be convinced that this is no imaginary cleanliness. Those not conversant with the admirable qualities of this metal base and who may have secured some misinformation from a prejudiced source may inquire as to why this mildly solvent action of the aluminum is not inimical to the health of the patient. I pondered a while as to whether I should discuss this threadbare subject of a few years ago, when propagandists were attempting to curtail the sales of aluminum cooking utensils. A few facts should satisfy the most skeptical; leaving the prejudiced to make the best of the facts.

Several years ago, one of our own profession, in an article on the deleterious effects of aluminum, caused a mild

1. Alcoa Aluminum and Its Alloys, Aluminum Co. of America.

furor, but no worth-while evidence in support of his contention was ever forthcoming. The fact that the article appeared in a small unscientific magazine may have lessened its appeal to those with sufficient intelligence to follow scientific developments with an analytic mind.

Twenty years ago, it was shown by investigators that we daily absorb aluminum in different forms.

The cooking of food in glazed (clay) vessels results in the slow but continuous liberation of aluminum salts. It may be seen, therefore, that aluminum does not necessarily present characteristics of toxicity. Certain experiments tend even to show that the presence of aluminum is necessary to the constitution of the cell. The complete harmlessness of the salts of aluminum cannot be doubted when one thinks that this metal is used daily and universally in the household. The most simple reasoning shows that if aluminum were a poisonous metal, as a small number of authors pretend, the health statistics, today so well established in every country, would record accidents produced from the use of this metal in our kitchens or in the food industries. While the bibliography of accidents due to the use of copper is considerable, there is no record of cases of poisoning charged against aluminum. The quantity of aluminum dissolved by liquids in contact with aluminum is much less than we absorb daily and normally in foods.[2]

Thinness of a denture base appeals to the senses of the average layman, yet it is this thinness that may operate as a positive detriment when we consider phonetics as one of the factors in successful construction of the artificial substitute. The anterior vault of most upper dentures should be thick immediately adjacent to the six anterior teeth in order to provide a buffer for the sounds produced in phrases containing the letter S. This thickness may be easily reproduced in the wax pattern. The additional weight is of no consequence in aluminum, but a similar design presents a real problem of construction in the swaged base denture.

The buccal and lingual borders of the aluminum base denture may be extended with impunity to the limit of tolerance, so that the operator does not, therefore, have to depend on vulcanite or any of the pink denture base materials to preserve the border seal against the ingress of air.[3] Aluminum is a good conductor of heat and cold, and, accordingly, permits the tissues of the mouth to receive the stimuli that vary with the temperature at which different viands are partaken and, in many instances, give to choice dishes their characteristic and more palatable flavor. Aluminum does not contribute to hyperemia of the tissues through maintaining them at an abnormally high temperature, as is often the case when the area is covered with a vulcanite or insulating base.

3. Aluminum may be dyed permanently a hue or color closely approximating that of the gum tissue. It is this phase of the procedure that promises to revolutionize our ideas as to what constitutes the ideal denture. The chemical attraction of aluminum for oxygen is one of the most important characteristics of the metal.[4]

The past ten years have seen much thicker oxide films the subject of intensive investigation and commercial exploitation. These thick oxide films are of interest, not

2. Hygienic Aspects of Aluminum and Aluminum Utensils, Bull. 3, Mellon Institute of Industrial Research, p. 26.

3. Campbell, D. D.: Full Denture Prosthesis, St. Louis: C. V. Mosby Publishing Co., 1924.

4. Edwards, J. D.: New Uses for Thin Films, Aluminum Research Laboratories, Aluminum Co. of America.

only for their electrical properties, but for mechanical, physical, and chemical properties, which are finding a host of uses for them.

If a sheet of aluminum is placed in a sulphuric acid bath or electrolyte and made the anode of the electrical plating equipment, an oxide film of 1 to 2 mm. in thickness may be deposited.

Sulfuric acid in certain concentrations and under certain coating conditions has proved a very versatile electrolyte constituent. Bengston has found that an electrolyte containing about 60 per cent sulfuric acid gives a coating which is highly adsorptive to dyes. Furthermore, the coating structure is such that thin aluminum sheet, coated and colored, can be stamped and formed into buttons, tags, and other small articles without injury to the coating. Gower, using sulfuric acid in a concentration of about 25 per cent, has produced coatings which combine good abrasion-resistance with color adsorption capacity. Tosterud has made highly abrasion-resistant coatings with an electrolyte containing about 7 per cent sulfuric acid.

The discovery by Flick that absorptive anodic oxide coatings could be colored by certain types of dyes marked the beginning of a new and remarkable development in the oxide coating of aluminum. The color penetrates the oxide coating throughout its depth and is absorbed and held so strongly that it is not readily dissolved, except by solutions which attack the oxide itself. It became possible to coat aluminum with a dense, hard, adherent oxide coating colored throughout with almost any color of the rainbow and with an endless number of tints and shades. The dyed oxide coatings made with selected dyes are relatively permanent indoors and show little or no fading in a 300-hour Fadeometer test with an arc rich in ultra-violet light. Outdoors, however, the dyes show fading in time. For severe service conditions, the oxide coating can be colored with inorganic pigments formed within the pores of the coating and held firmly absorbed. The range of colors, however, is somewhat limited.

The question of permanency of color when bathed in the oral secretions of the mouth is yet to be determined by actual test.

A superficial and wholly inadequate test, made by "wearing" a brilliantly dyed yellow lozenger of aluminum in the mouth for days, showed no effect on the color.

The abrasion-resistance of the oxide coating is of importance in many applications. This resistance to wear is greater in general, the thicker the coating, although the oxide itself will vary in character, depending upon the conditions of application. A quantitative measure of abrasion-resistance is obtained by a test which consists in abrading the surface with an Aloxite wheel under light pressure. The abrasion-resistance is measured by the number of revolutions which the specimen makes against the abrasive wheel before the coating is worn through. A series of values obtained in this way are given in the accompanying table.

Abrasion-Resistance of Oxide Coatings as a Function of Thickness

| Thickness of Coating | Abrasion-Resistance Against Aloxite Wheel |
|---|---|
| Inches | Revolutions |
| 0.00011 | 15 |
| 0.00019 | 95 |
| 0.00031 | 268 |
| 0.00037 | 365 |
| 0.00074 | 2,563 |
| 0.00148 | 7,061 |

These values are much higher than those obtained with baked enamel coatings, such as are applied in finishing metal furniture, even though the enamel coating be very much thicker.

The oxide coatings produced electrolytically on aluminum when subjected to x-ray examination show no evidence of crystallinity and appear to be amorphous. Small amounts of water held in the coatings are

probably held by adsorption, as there is no evidence of any hydrate of aluminum. However, by a special after-treatment the oxide can be converted, at least in part, into crystalline monohydrate, a change which is accompanied by a marked decrease in the permeability and an increase in its dielectric and protective properties. While, for purposes of coloring, an adsorptive film is desired, for many purposes a film is needed which is completely impervious. A variety of sealing treatments have been developed to accomplish this result without changing the appearance of the coating. Still other sealing treatments markedly increase the corrosion-resistant properties of the coating.

The uses for the oxide-coated and colored aluminum are on the increase. Several million pounds of aluminum articles of one kind or another are so treated every year, which is a well-merited tribute to the serviceability of these coatings.

4. Aluminum is the least expensive of all the denture base materials. Commercial aluminum sells today at approximately 20 cents per pound. The alloy of aluminum and magnesium (3.75 per cent) designated as Alcoa No. 214, until recently sold for 23.5 cents a pound in 5-pound lots. On the basis of each denture weighing 1 ounce, this expense to the dentist was less than 1.5 cents for each casting.

Now for a lesson in the economics of supply and demand: This summer, I appeared before forty-five dental groups. A part of the day was devoted to demonstrating the merits of this new alloy, demonstrating the actual casting of a denture base and the retention possible in the mouth of an actual patient, and this without swaging.

Immediately, dentists in increasing numbers ordered Alcoa No. 214. The demand sent the price up to $1 a pound, an increase of over 300 per cent, so that now the cost to the dentist is approximately 5 cents a base. The cause of this tremendous advance was no doubt the size of the order. An order of a pound of aluminum from this organization is about as profitable as the druggist's sale of postage stamps. I am so taken with the beauty of the castings and their receptiveness to colors that I would contemplate another raise without perturbation. A duplicate in gold would cost 700 times as much, and, with the usual alloy of copper to reduce the carat for strength, would quickly tarnish in that part of the intaglio not readily accessible to a militant plate brush. The resistance to lateral strain on the gold base denture is not comparable to the same stress placed upon a base of Alcoa No. 214. The steel base is in the same category with the gold base, but, in my judgment, 1 or 2 per cent better than gold in resistance to lateral stress, and probably of higher hygienic value.

Steel bases may be reinforced and trussed near the frenum and across the median or symphyseal line so that, in strength, they will approach the magnesium aluminum alloy, but the equipment necessary to effect this type of structural design cannot be bought in a hardware store. Should one of the "mother" laboratories correctly interpret and follow your instructions, they would be justified in increasing the cost of the base from 10 to 20 per cent, all of which has a bearing on this phase of my paper: i.e., cost. The aluminum alloy is the cheapest and best denture base on which to attach teeth.

5. Aluminum denture base construction presents no greater difficulties than the cast gold inlay. The novice in casting aluminum should pour his impression of one of the newer synthetic stones, not because strength is needed as was formerly required in swaging pure cast aluminum, but because many of the newer products properly mixed show a mini-

mum of expansion. With a master model, should the amateur fail in his first attempt, he is saved the necessity of securing another impression. Without any desire to be facetious or pedantic, but as a member of the Nomenclature Committee of the A.D.A., I desire to call attention to the fact that the term "model" in the foregoing sentence is used correctly. It is gratifying, in dental literature, to encounter this term "model" and know that a reproduction of the physical form that cast takes is intended. Dressmakers, blacksmiths, patternmakers and the average laymen use the term correctly, but not so the majority of dentists. Our dental forbears employed the term "model" correctly because they used it as meaning to reproduce its counterpart in metal—a die for swaging. It is a holdover from that day in 1840 when Goodyear's latex mixture spilled over on the hot stove pipe and vulcanite was discovered.

Plaster models are not reproduced in the vulcanizing process. Anything "thrown" (*castra*—to throw) into an impression of the jaw is a cast, becoming a model only when a replica is to be made.

This replica is made by surrounding the model-cast with one of the commercial colloidals now used extensively for securing impressions of partially edentulous jaws.

A refrigerator dish with large holes ground widely apart in its base makes a very satisfactory flask for holding the duplicating matrix. The base of the model is stuck to a piece of window glass with beeswax or plasticene one-half the size of a pea and, with a small soft brush, the model is washed with laundry soap, the operator holding it under cold running water for a moment to wash off the excess soap. Do not be afraid you will wash off the newly formed thin film of calcium sterate, which is the real medium. This bit of technic is not desirable for plaster impressions when a hard surfaced cast is desired. The gelatinous duplicating remnants are heated in a double boiler, about 50 per cent water being added, and poured when it can be stirred cautiously with the bare finger or at a temperature around 130 F.

With the addition of so much water, the matrix is a bit more frail, but the volumetric change is lessened and a faithful reproduction is assured. It is placed in a refrigerator or the holes in the glass flask are covered with cardboard, and the whole assemblage is weighted down in a bucket and surrounded with ice or running cold water. The matrix is pressed out of the glass container with the thumbs at the holes, while the tips of the fingers hold the bottom of the glass flask.

Any excess of the duplicating material that may have run under the model is now trimmed away with a knife, the model removed and the matrix filled with a superior crown and bridge investment of the following:

3½ pounds or parts of white lake sand
2 pounds or parts of cast plaster or modified "hydrocal"
1½ pounds or parts of painters silex-4-x

I have used this formula for more than twenty years in practice and in college work, and it is better for this technic than any commercial product with which I am familiar because it contains more sand. Another feature in its favor is the facility with which the ingredients can be obtained. White lake sand is of a sharp crystalline structure in contradistinction to sea or river sand, which microscopic examination shows to be of spherical form. It has various uses. Glass grinders use it for the first rough polishing of glass; hotels to fill jardinieres to be used as receptacles for cigaret butts. Children enjoy it in playground sand piles. In Kansas City, it is delivered for 60 cents a

hundred pounds. Cast plaster, the second ingredient, is used instead of impression plaster because the latter is too fine and too highly calcined and sets too quickly. Recently, I have been using a commercial modified "hydrocal" instead of cast plaster and I like it better because it is harder and, when heated, less friable.

The third ingredient, painter's silex, may be had from any paint store. It is used as a filler in finishing hardwood floors, and costs 2.5 cents a pound in 50-pound bags. The only secret formula with which I am familiar that approaches this "home-made" investment in texture and working qualities sells for $3 a can. A like amount of "home-made" investment should cost less than 30 cents. Large quantities should be mixed in a 10-gallon dairy tumbler churn into which dissembled vulcanite flasks, sticks or large bolts are thrown to aid in thoroughly mixing the ingredients. The churn is turned at the rate of about twenty revolutions a minute; i.e., slowly.

An alternative method is to pour the investment directly into the original impression. A small cast of this investment is desirable because there is no use for any part of it except the tissue-bearing surface. A small cast makes it possible to invest the wax pattern easier in the cowbell flask.

The pattern is waxed directly to the investment cast with any of the commercial waxes that burn without residue. Beeswax expressed from a sprue gum into wirelike forms makes easy the problem of design. Beeswax is slightly sticky and stays in place better than the paraffin waxes. The base should be provided with ample attachments for the material that is to be used to hold the teeth on it. These are supplied in abundance with the wax wire.

The subsequent technic after investing the cowbell flask, casting and finishing is given in detail in an article in THE JOURNAL.[5]

Since that article was written, I have eliminated the very objectionable fault of minute sandpits in the castings.

When the case is ready to be cast, the crucible portion of the cowbell is inverted and held over the edge of the bench. A stream of air from the blowpipe at a pressure of about 20 pounds is forced through one sprue hole and then the other, with the result that any sawtooth fins or loose particles of investment are dislodged and blown out of the mold. The chain is now hooked in the bell. The aluminum magnesium alloy is melted in the improvised crucible with a gas or gasoline blowpipe, *not* prestolite, and, when molten, the cowbell flask is swung easily and deliberately over the head and under the knees, parallel with the body, at a speed of about one revolution a second. As a matter of convenience, the casting operation is performed while the bell is hot. A cold flask, free from moisture, gives equally good results.

In finishing and polishing cast aluminum bases, tripoli and fine carborundum incorporated in a tallow base is more satisfactory than pumice.

5. Campbell, D. D.: Cast Swaged Aluminum Base Denture, J.A.D.A., 22:2082 (Dec.) 1935.

# THE PARTIAL DENTURE AS A VEHICLE FOR FUNCTION*

By DAVID W. McLEAN, D.D.S., Los Angeles, Calif.

IN the newer concept of dentistry as a department of preventive medicine, all dental practice has two basic aims. First is the prevention of systemic diseases caused or complicated by oral foci of infection. In the light of this aim, operative dentistry ceases to merely stop or prevent toothache by plugging cavities in teeth: it must seal the tooth against bacteria, must fight constantly the insidious progression from the small carious lesion to the periapical focus of infection.

The second basic aim of modern dental practice is to aid in preventing metabolic disturbances, derangements of internal functions, intestinal putrefaction, autointoxication and lowered resistance to general infections. This dentistry does by maintaining, improving and restoring efficient masticatory function. In the light of this aim, operative dentistry faces added problems, for gnathodynamic tooth anatomy must be incorporated in every tooth restoration. At the same time, prosthetic dentistry must cease to provide mere cosmetic and space-filling gadgets, and must provide instead oral remedies that will assure occlusal coordination and masticatory function.

All remedies consist of two parts: a therapeutic principle and the vehicle that carries it. In medical practice, the shape and color of the pill are of slight interest to either the physician or the patient, as long as it effectively carries the drug.

The dentist must be his own pharmacist and, in dental remedies, the therapeutic principle consists largely of intangible qualities in the material, form and application of the vehicle. Moreover, the vehicle, as in the case of the partial denture, is very much in evidence even after it is applied to the patient's mouth. Naturally, then, the minds of both dentists and patients are prone to focus on the vehicle rather than the therapeutic principle that it carries. Thus, it happens that we have "precision attachment" dentists, "Roach" men, "Akers" men, "Nesbett" men.

It is no honor, in this advanced day, to be known as a partial denture "system" man. The well-qualified dentist should be sufficiently versatile to analyze the functional needs of the patient; to visualize the therapeutic principles needed to meet them; to design and produce the vehicle best able, within the patient's ability to provide for himself, to synthesize and maintain masticatory function.

To establish and maintain by partial dentures a degree of masticatory ability satisfying modern dentistry's second basic aim, without violating its first aim by inducing dental, periodontal or edentulous ridge disease, is one of the most difficult problems of dental practice today.

*Read before the Section on Partial Denture Prosthesis at the Seventy-Seventh Annual Session of the American Dental Association, New Orleans, La., Nov. 6, 1935.

First of all, we must realize that function means work and that work is always accomplished by conflict between force and resistance. In masticatory function, the force is supplied by a powerful musculature, which clamps the mandibular teeth against those of the maxillae and then drags the mandible across from the terminal position on the so-called working side, through the centric area and over to the opposite termination of cusp contacts, where the jaw is opened and returned for the beginning of another chewing stroke.

During the chewing stroke, all of the teeth are under stress. In conditions of stress, force is exerted mutually between two bodies, or between two portions of a body. When the musculature causes the mandibular teeth to exert force against the maxillary teeth, the latter exert an equal and opposite force against their mandibular opponents. The teeth are mere intermediaries and pass the force on to their periodontium, which exerts an equal and opposite force against the teeth. Thus, the entire periodontium of both jaws is in a state of stress and offers the resistance to muscular force necessary to accomplish the work of mastication.

Both the force and the resistance of masticatory function, then, depend on the metabolism of living tissues. The metabolism of the musculature is rapid and great; that of the supporting bone, sluggish and limited. If the periodontium is to last out its normal span, the force of mastication must be distributed equally over the entire masticative area. If, through cuspal antagonism, this constantly renewed muscular force is exerted against the periodontium of one tooth, that tooth is doomed. If because of arch vacancies, the force is directed against a few teeth, the mineral metabolism supporting them will lag behind the demands made on it, and, in time, the periodontium will succumb.

It is in such situations that the partial denture is prescribed for a twofold purpose: to carry on the functions of the lost teeth for the sake of bodily health; and to distribute to edentulous ridge areas some of the onerous burden of mastication; which prevents periodontal pathosis of the remaining teeth and its accompanying infection.

The outstanding therapeutic principle to be carried by the partial denture vehicle, then, is effective masticatory function. A second therapeutic principle, which makes effective the first one, is the stability of the vehicle upon its resilient and nonresilient supports. If the vehicle does not carry these two therapeutic principles, it is an innocuous dental breadpill. If it unduly injures its supports and permits drifting and extrusion of neighboring or opposing teeth, further deranging the masticatory mechanism, it becomes an active dental poison instead of a remedy.

The two therapeutic principles of the partial denture, stabilization and function, are closely interrelated. Stabilization renders mastication more effective, while efficient and nonantagonistic mastication simplifies, and renders permanent, stabilization.

The basic problem of partial denture stabilization *per se* is to equalize the resilient and nonresilient supports. Either the nonresilient supporting teeth are made movable—which unfortunately occurs with many partial dentures—or the resilience of the mucosa must be reduced. Mucosa resilience can be reduced, but not overcome, and after it is reduced, some means must be found to equalize the slightly resilient and the nonresilient supports.

The first measure for reducing mucosa resilience is to pare from the ridge ex-

cessive masses of soft tissue. This simple procedure calls for procaine infiltration, the use of curved lances and a surgical dressing (pack) applied in the preliminary denture or in a specially constructed hard base with a bite-rim built to occlusion.

Preliminary dentures also compress the mucosa, as does the impression for the working model.

An effective impression technic is one using a stiff mix of impression cement spread on a tray made of vulcanite, cast metal or hard denture base reinforced with wire, and having modeling-compound biteblocks. The tray ends at the gingival line of the remaining teeth. The impression of edentulous areas is taken with the cement, under biting pressure and left in position while bite registrations and transfer of orientation are made. Finally, a colloid impression is taken over all; and the cement edentulous-ridge impression is removed in it and, if slightly dislodged, is firmly seated again. This technic provides tissue compression of edentulous areas and accurate reproduction of the remaining teeth.

Large denture bases also tend to reduce mucosa resilience and denture rocking, since denture bases operate on the principle of snowshoes.

The next factor in stabilization is adequate attachment to the supporting teeth. The stabilizing attachments should offer a minimal menace of caries. They should have occlusal rests and should not be too movable on the teeth. Loose, unsteady stabilizers should not be considered a means of support equalization (stress-breaking). They permit reckless denture movement, which, in time, will ruin the supporting ridge and the periodontium of supporting teeth. The addition of auxiliary stabilizer bars to such an appliance will not steady it, but will exert pernicious leverage on some "innocent bystander." Auxiliary stabilizers, including all unreciprocated occlusal rests and clasp arms, are, at best, perverted orthodontic appliances.

When precision attachments are beyond the patient's means, the decision between circular and bar clasps should be based on the form, position and condition of the supporting teeth, and the means to be used for support equalization. If a bar type clasp is desired, but plastic bases must be used, the "open clasp" is indicated.

Equalization of the resilient and nonresilient supports is accomplished by interposing between the supporting teeth and the movable denture either resilient metal or movable joints.

The action of the resilient metal support equalizer may be illustrated by an open clasp with a horizontal bar extending distally from it, placed on a metal tooth having a metal root embedded in a periodontium of soft velum rubber. Downward pressure on the bar moves the tooth in its periodontium. As the force accumulates, the inertia of the resilient clasp arms is overcome. They bend and slide upon the tooth, but the tooth remains under tension.

The movable support equalizer permits the mucosa to take the first brunt of force and should, ideally, reach the limit of its mobility when the mucosa is fully compressed. The resilient and nonresilient supports are then equalized and carry the load together.

My first choice for the stabilization factor is the precision attachment and the distal extension support-equalizer. Second comes the rigid nonprecision attachment with distal extension equalizer; and, third, resilient connectors or resilient clasp arms or both. In no case should rigid attachments, whether precision or nonprecision, be used without means for

equalization of the resilient and nonresilient denture supports.

The distal extension support equalizer consists of an extension bar housed in the "dentofact" (artificial or manmade tooth) adjoining the supporting tooth and movably secured in its housing by a screw. Judicious filing will develop immediate mobility when it is needed.

The distal extension equalizer may be used in conjunction with clasps. A wrought extension bar may be incorporated in the clasp or a wax bar may be formed, attached to the clasp pattern and cast integrally with it. The clasps are waxed on a model made of investment material, and the extension bars are roughly paralleled. All other metal parts may be waxed on this model and sprued to a single button, so that they may be cast in one operation. After the extension bar is polished, a housing is formed about it in wax, invested and cast. Housing and bar are then drilled to receive the screw that holds them together but movable. If plastic bases are to be used, the equalizer-assembly is filled with plaster before the waxing of the case.

The partial denture's therapeutic principle of stabilization calls, then, for the coordination of several factors. Its major therapeutic principle, masticatory function, likewise depends on the harmonious correlation of several factors. They are the factors in gnathodynamic, as opposed to gnathostatic, occlusion and they are always more or less deranged in patients of partial-denture age.

Masticatory function is not normally performed in static or centric closure. The plane line articulator and gnathostatics must give way to the physiologic articulator and the more complex principles of gnathodynamics. For teeth may interdigitate excellently in static closure, but fail utterly to function in the gnathodynamic relationships of functional jaw movement.

Taking for granted the masticatory musculature, the first gnathodynamic factor of occlusion is the anatomic structure of the temporomandibular joints. This is a composite factor, made up of the combined pivoting and Bennett movements of the condyle head on the working side and the combined forward, downward and inward movement of the condyle-head on the balancing side. In protrusive movements, it is made up of the downward and forward movements of both condyle heads.

Undoubtedly, many temporomandibular joints of partial-denture age come to us deformed by occlusal maladjustments, particularly when the patient has found greater masticatory efficiency by chewing habitually in an unnatural jaw position, which may be termed a "convenience bite." Changes in the temporomandibular joint depend largely on bone resorption and bone generation and take place slowly; and, from a clinical standpoint, these joints must be considered a nonpliable factor in gnathodynamic occlusion.

Another factor in gnathodynamic occlusion dependent on the temporomandibular joints is their hinge axis movement, and the importance of this factor is not sufficiently realized.

All changes in the level of jaw closure take place on this hinge axis. If through wear or loss of teeth, the jaw closes beyond its normal level, the denture moves forward as well as upward. Since its axis is located above and behind the dentures, the mandible assumes a position of Class 3 malocclusion, evidenced by the prognathous appearance of the patient.

Bite closure, therefore, brings excessive pressure and wear on the anterior teeth and changes the relationship of lower to upper teeth and cusps and the

angle of delivery of axial stress to the teeth.

Conversely, when the bite is opened, the jaw and the mandibular denture move posteriorly as well as downward, since, again, the change of vertical dimension takes place on a hinge axis located above and behind the dentures. This may change the cuspal relationship between upper and lower teeth from interdigitation to a cusp-to-cusp relationship, and has led to the harmful custom of moving the mandible forward until upper and lower cusps again interdigitate; in other words, prescribing a convenience bite, this time for the convenience of the dentist treating the case. Long before bone changes in the temporomandibular joints could accommodate the jaw in its new position, the periodontium will be broken down by repeated pressure on the inclined planes of cusps, when the jaw fails to occlude in exactly the prescribed position.

Changes of biting level must be made on the correct hinge axis or there will be excessive pressure in some localized portion of the dentures, determined by the direction of mislocation of the axis. The patient's own axis must be used by making the change of vertical dimension in the mouth; or, if the change is made on a hinge axis articulator, the axis must be correctly oriented in relation to the models.

The gnathodynamic hinge axis cannot be located by measurements made on the patient's face. It must be accurately located as a point of nonmotion during mandibular hinge movements, and the orientation must then be accurately transferred to the articulator.

The operation of restoring occlusal coordination to the worn out dentures of partial denture age is sometimes spoken of as "bite raising" or "elevating the bite." A change of biting level is only one of the factors in developing gnathodynamic occlusion, and it is one, moreover, to be used sparingly.

Another factor of gnathodynamic occlusion is the curvature and the pitch from horizontal, of the occlusal curves. Wear may flatten or invert them or break their continuity. It is often necessary to correct the occusal curves, but not to the arbitrary 8-inch sphere advocated by Monson.

If so-called anatomic biteblocks are made to slip on over any natural teeth and so shaped as to maintain occlusal contact throughout the range of functional jaw movement, the occlusal surfaces of these blocks should, according to Monson's theory, form part of an 8-inch sphere. If an 8-inch disk is applied, in various positions and directions, to the occlusal surface of the lower biteblock, the fallacy of this theory is quickly seen.

The occlusal curves, as individualized by Wadsworth, are used as the starting point from which variations of cusp position are worked out reciprocally between upper and lower teeth. Articulators on which occlusal coordination is to be synthesized should therefore carry a Wadsworth semaphore, that the basic and occlusal curves most compatible to the case may be surveyed and prescribed.

The fourth factor in gnathodynamic occlusion is the combined overbite and overjet of the anterior teeth. This is a pliable factor, and may be deranged or corrected by changes in the level of jaw closure. Bite closure increases the overbite and decreases the overjet, while bite opening decreases the overbite and increases the overjet.

The fifth factor is the position, length and angulation of the cusps of posterior teeth. This is, of course, a pliable factor, since the cusps of dentofacts may be changed by moving, tipping, rotating or grinding, while those of natural teeth may be altered by removing old fillings,

etc., veneering the occlusal surfaces with hard metal having cusps and fossae appropriately placed and formed.

During a perfectly coordinated protrusive jaw movement, the condyle heads move downward and forward on their condyle paths. The mandibular denture moves down the pitch and around the curvature of the longitudinal occlusal curve (of Spee). At the same time, posterior cusps move down the planes of their opponents until the cusps are peak to peak; and, meanwhile, the anterior teeth move diagonally down the overbite and across the overjet until they are edge to edge.

In lateral mandibular movements, the picture differs slightly. The condyle head on the working side pivots and perhaps moves bodily sideways. The opposite condyle moves downward, forward and inward on its path. The working side of the denture moves more largely across the lateral occlusal curvature, while that of the balancing side moves laterally and longitudinally on the occlusal plane. Meanwhile, the posterior cusps move from the occlusal fossae down the cusp planes to the cusp peaks, creating what is known as the opening component of the lateral jaw movement, and this component is gained, in at least a large number of cases, by hinge opening of the jaw on its gnathodynamic hinge axis. This is a significant fact since it involves all lateral jaw movements and calls for hinge axis orientation regardless of the type of articulator used.

In the lateral movement, the lateral overbite of the cuspids becomes a prominent factor. In many cases, the cuspids are excessively long. To coordinate the occlusion to them would require excessive bite opening or excessively long cusps, or both. After the models are oriented on the articulator, the long cuspids are reduced and the bite is then opened sufficiently to permit of coordination between the cuspids and the posterior teeth.

While wear has been changing the level of jaw closure, deranging the occlusal curvature and pitch, altering the overbite and overjet and flattening out the posterior occlusal surfaces, fillings and inlays, tooth-borne bridges and other prostheses have been supplied from time to time, and these have necessarily been shaped to harmonize with their deformed environment.

It is, of course, possible to prescribe partial dentures which, too, will conform to the wrong environment. Indeed, unless the patient is able to provide adequately for himself or until dentistry has become socialized in such a way that every patient may have the best dental service, such must be the procedure. For the operation of coordinating these gnathodynamic factors is intricate and time-consuming and few dentists can afford to present a service of such magnitude to their patients without adequate remuneration.

Nevertheless, the complete restoration of function to partial denture patients must be every dentist's ideal, and every dentist should be fitted to fulfil the ideal, for a thorough knowledge of dynamic occlusion will enhance the value of every operation the dentist performs.

The coordinating of these factors in gnathodynamic occlusion is palpably too complicated a procedure to attempt in the patient's mouth. The operation must be transferred to a gnathodynamic articulator, capable of reproducing jaw positions with at least reasonable fidelity. Orientation of the models on the articulator and the making and application of bite registrations must be accurate to a degree.

Incorporated in the working models will be the amalgam dies representing any natural teeth that have been prepared

to receive inlays, occlusal veneers or three-quarter or full coronal veneers (crowns). On these models, the occlusion is first developed in wax. When satisfactory cuspal cooperation is obtained, the occlusal surfaces are reproduced in hard metal prostheses for the natural teeth and dentofacts of porcelain for the partial denture. Under and about these dentofacts, the partial denture bases and attachments are made, without altering the occlusal relationships already established.

When the remedies are applied to the mouth, the correction of excessively long teeth that was made on the mounted models is reproduced in the mouth by selective spot-grinding, until the same coordination that was produced on the articulator obtains in the mouth.

The same principle should be used even when function cannot be fully restored in the case in hand. Interfering cusps or anterior teeth should be reduced by selective spot-grinding on the model. Perhaps the occlusal surface of an interfering tooth may be reformed in wax, on the model, so that the denture dentofact can be formed to cooperate with it. On applying the finished denture to the patient's mouth, the same adjustments are made on the natural teeth by selective spot-grinding; and the posterior tooth that was corrected on the model is given an occlusal veneer, the wax pattern for which is formed on a die and developed in the mouth to cooperate with the opposing dentofact during jaw movements.

The principle for synthesizing gnathodynamic occlusion is simple, but its application is difficult enough. Suppose that, in the working position, the buccal cusps of the upper and lower first molars do not make contact. The simplest correction will be to lengthen the upper cusps by tipping the buccal side of the upper dentofact downward (or building on more wax, if the occlusion is being developed in wax), for the reason that the upper buccal cusps do not enter into centric relationship. If the models are moved to protrusive relationship, it may be seen that the lengthened upper cusps would interfere in that relationship. In that case, the lower buccal cusps are lengthened and made to conform to the upper ones in the working lateral position.

When the models are returned to centric relationship, the lengthened lower cusps will be too long and a reciprocal adjustment must be made, deepening the fossae of the upper molar to receive them. Other adjustments must perhaps be made in the upper teeth to accommodate the altered lower cusps in protrusive relationship.

Each cusp is formed to make the necessary contacts in right and left lateral, protrusive and centric relationships. The paths between those positions are coordinated by carving or selective spot-grinding.

Since, at the present time, bite registrations and articulator controls reproduce with fidelity only the four jaw positions, the intervening paths, as expressed in the cusp planes, may require refining in the mouth by selective spot-grinding.

Selective spot-grinding is a time-consuming and hazardous operation in the course of which many dentures, both natural and artificial, have been ruined. A strip of carbon paper is placed between all of the posterior teeth on each side of the arch. The patient closes in centric relationship, makes one lateral stroke and opens the jaw. Carbon marks are found on all of the teeth. Part of each mark was made in centric relationship and part in the lateral movement. Therefore, all spot-grinding should be selective. To cut off the entire carbon mark is to ruin all chance for cuspal coordination. The marks must be carefully interpreted and only the portion that represents inter-

ference should be removed. The cut, which is made with carborundum points, is deepest at the point of greatest interference, tapering to nothing as the zone of noninterference is reached.

To maintain its status as a therapeutic agent, the partial denture must have periodic inspection, and corrective treatment when necessary. The need for correction, and its extent, will be inversely proportionate to the excellence of the therapeutic principles that have been incorporated in the vehicle.

SUMMARY

Present knowledge of the importance of dentistry in the field of preventive medicine places new and important restrictions and requirements on the dentist. In operative dentistry, he must do more than "fill cavities": he must eradicate disease and seal the tooth against bacteria, combating always the insidious progression from the small carious lesion to the periapical focus of infection and systemic disease. He must also, by careful attention to gnathodynamic tooth form, develop, in all tooth-restorative operations, the highest degree of masticatory function, for the prevention of periodontoclasia and the general syndrome that follows on inefficient mastication.

In partial denture practice, the dentist must avoid all practices that tend to induce dental, periodontal or ridge disease, while he, at the same time, coordinates all factors of practice to produce the highest degree of masticatory efficiency. He must recognize the partial denture *per se* as a vehicle only, designed to carry the more intangible therapeutic principles of healthful, enduring stabilization and masticatory function.

Stabilization is achieved by: 1. The reduction of mucosa resilience by surgical measures, by the wearing of temporary dentures, by the impression technic and by using large denture bases. 2. Attachment of the denture to the natural teeth, by stabilizers not too freely movable. 3. The interposition between the supporting teeth and the movable denture of some means for equalizing the resilient and nonresilient denture supports. This equalization is obtained by means of movably jointed connectors or resilient connectors and clasp arms.

Masticatory function depends on the correlation of the several factors in gnathodynamic occlusion: the mandibular controls in the temporomandibular articulation; the curvature and pitch of the occlusal curves; the combination of overbite and overjet, and the position, height and angulation of the cusps.

All of these are influenced by wear, and the loss and drifting of teeth. Those susceptible of correction are termed the pliable factors in gnathodynamic occlusion. Their correlation is intricate and demands the use of a gnathodynamic articulator, together with accurate orientation of the models and accurate use of bite registrations.

Since present articulators reproduce only the terminal positions of the jaw, the intervening paths of cusp travel must be harmonized by selective spot-grinding.

The synthesizing of gnathodynamic occlusion and its refining by selective spot-grinding depend on a well defined principle: that cusps shall be harmonized to one jaw movement and position without detracting from their shearing contacts in other jaw movements and positions.

Only that partial denture vehicle which carries these therapeutic principles becomes a true remedy. Lacking them, it becomes a dental bread-pill. If, in addition, it induces dental, periodontal or ridge disease, or causes or permits further derangement of the masticatory mechanism, it becomes an active dental poison.

3780 Wilshire Boulevard.

# PORCELAIN DENTAL RESTORATIONS*

By H. SPALDING BOTH, D.D.S., New York City

## PROCEDURE FOR PREPARATION OF VITAL TEETH FOR PORCELAIN JACKET OR VENEER CROWNS

BEFORE starting the actual operation for preparation of vital teeth for porcelain jacket or veneer crowns, the operator should carefully consider the advisability of resorting to this particular form of restoration. He should examine the tooth in question and determine whether this form of restoration will preserve the tooth to a greater degree than any other form of replacement. Having decided on a jacket, or veneer crown, he should make a roentgenographic examination to determine the size and shape of the pulp, the thickness of the enamel capsule and the topography of the environment and investing tissues. An accurate pulp test and a study model made from a modeling compound impression should also be taken.

In vital molars and certain bicuspids, I prefer to remove the enamel on the sides of the tooth with a No. 700 cross-cut tapered fissure bur, which is used after the occlusal preparation has been completed. (Fig. 1.) The No. 700 bur is placed between the enamel wall and the dentin and its progress is observed through the thin enamel wall. The bur must be kept in close contact with the inner wall of enamel at all times. When it is cut to the proper depth, the enamel is readily chipped off, leaving the shoulder almost entirely prepared.

In peg-shaped lateral incisors, in the teeth of younger patients and in certain first upper bicuspids, it is often advisable to construct shoulderless crowns.

In the case of the first upper bicuspids, where two roots exist, which may bifurcate near the neck of the tooth, the vitality of the tooth is threatened by construction of a shoulder. A cast gold shoulder may be made into which is carved the shoulder for the jacket crown. In the longer anterior upper teeth, the shoulder need not be cut under the gum margin on the palatal surface.

Where much gum recession has taken place and the cementum has become exposed, the shoulder may have to be cut incisally to the soft tissues on all surfaces in order not to jeopardize the vitality of the pulp.

In vital short-bite molars, it is advisable to make a gold jacket and insert in its occlusal surface a porcelain inlay, thus giving the strength of a gold jacket and yet showing no gold where it is most likely to be conspicuous. The gold jacket entirely encases the vital tooth, even under the porcelain occlusal inlay. This precaution protects the tooth even if the occlusal inlay is absent. The gold is burnished over the porcelain inlay margins while the cement is still soft. This facet of gold will hold the porcelain inlay even if it should break. This type of jacket crown also makes a desirable bridge abutment. (Fig. 2.)

*Read before the Section on Operative Dentistry at the Seventy-First Annual Midwinter clinic of the Chicago Dental Society, Feb. 20, 1935.

PORCELAIN INLAYS

In the case of a gingival cavity, the wall nearest the incisal edge is deeper toward the floor than at the margin. (Fig. 3.) Thus, solid tooth structure is between the margin and floor of the inlay all along this part. This prevents cement showing through at the margin. If "kryptex" is to be used, a wheel bur is run around the walls of the cavity, forming a groove, and a groove is also created all around the sides of the inlay and the floor of the inlay roughened with hydrofluoric acid. The cavity must not be dehydrated too much if "kryptex" is used.

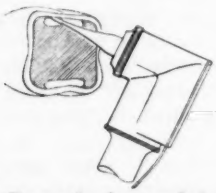

Fig. 1.—Removal of enamel in posterior teeth by cutting between enamel and dentin with a No. 700 fissure bur. The prepared occlusal surface must have cusps and sulci in order to have an even thickness of porcelain on the morsal surface.

Fig. 2.—Vital short bite molar with gold jacket in occlusal surface of which porcelain inlay is placed.

A cavity involving the labial and palatal surfaces, the incisal natural tooth remaining in position, is shown in Figure 4.

A sectional tray for the impression of the cavity in Figure 4 is shown in Figure 5. The long narrow tapered piece of metal, about 30 to 34 gage, of stiff material, is bent at right angles at the dotted line and its widest part adapted to the palatal surface. The remainder of this part of the tray stands out straight labially through the interproximal space. A flat piece of metal is now taken and a slit cut through its center which can be slid over the first part from a labial direction and which is slightly contoured to fit the general labial surface of not only the tooth with the cavity, but also the approximal tooth. We now take each part of the tray separately, the long narrow one first, and place some modeling compound over its widest surface. The compound is lubricated and the tray is

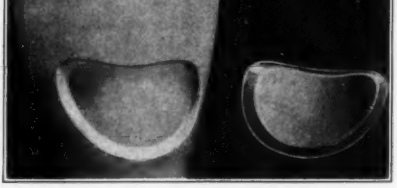

Fig. 3.—Gingival cavity preparation, showing incisal wall.

Fig. 4.—Cavity involving labial and lingual surfaces, incisal natural tooth tip remaining in position.

inserted and brought to position from the palatal aspect. The compound is now chilled, and the access, which has been forced out over the labial part of the cavity and tooth, is trimmed off with a sharp instrument until the operator is able to remove this part of the impression tray in a palatal direction, e.g., opposite to the direction of insertion. This part of the impression is reinserted in a chilled condition and held firmly in place. The broad slitted

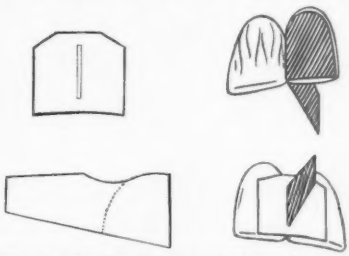

Fig. 5.—Sectional impression tray for cavity shown in Figure 4.

Fig. 6.—Method of retention in case of a fractured tooth and healthy dentin.

labial tray is now covered with modeling compound and lubricated, and slid over the protruding arm of the palatal tray from a labial direction and allowed to chill. The labial tray is then removed in a labial direction and the palatal section in a palatal direction. The two sections are then reassembled and an amalgam die is poured. This sectional method of impression taking is most commendable. It not only results in an accurate impression of the cavity, but also permits the proximal and labial surface of the adjacent tooth to be used for contact point restoration, tooth outline, etc.

### ONE OF MANY METHODS OF OBTAINING MARGINAL FIT

The cavity margins will fit in direct ratio to the skill, time and effort that the operator puts into them. It is not possible always to obtain good results by the indirect method alone, and those who have tried this procedure have not been able to obtain the same results that they have obtained in making gold inlays. It is just as possible to obtain perfect margins with porcelain inlays as it is with gold inlays, only it requires more patience and time.

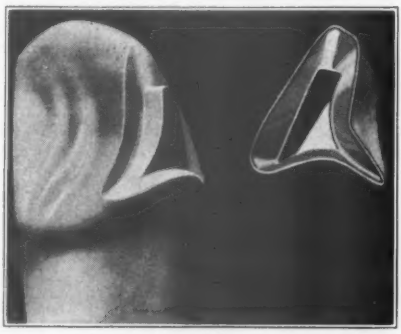

Fig. 7.—Method of retention in case of fractured tooth and healthy dentin.

Fig. 8.—Incisal fracture.

There are many ways of obtaining this result, and one should determine which one of these methods should be used in a given case. For example, excellent results are obtained by making two dies. The first die is obtained from the usual modeling compound indirect impression, which may be poured in "kryptex" or artificial stone. Upon this die, a matrix is swaged and refitted into the actual cavity in the mouth. This matrix is then burnished to the actual tooth cavity very carefully with instruments, cotton and spunk. When this is completed, the

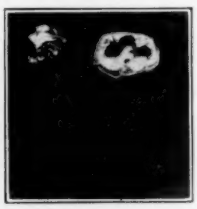

Fig. 9.—Occlusal cavity with matrix swaged in two parts.

Fig. 10.—Occlusal molar preparation with finished inlay.

matrix is filled with inlay wax, which should be so softened that it will act as a plunger, thus swaging the matrix into the tooth. The matrix thus burnished is then removed and a second die is made in amalgam from this direct matrix. The amalgam poured upon the platinum matrix will not adhere to the platinum foil. The inlay is then completed to a high underglaze and again fitted to the actual tooth, while the matrix still surrounds it. At this time, the margins may again be burnished and polished and finished flush to the cavosurface angle. If any discrepancies exist, they may now be corrected by adding more porcelain in the space between the finished underglazed porcelain and the platinum matrix. The inlay is then glazed and the matrix is removed. Burnishing the matrix at the margins has the added advantages of considerably reducing the gage of the foil. Porcelain inlays may

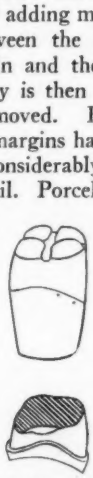

Fig. 11.—Shoulderless molar veneer crown preparation with gold coping in which is carved false shoulder.

Fig. 12.—Pulpless molar restored with gold coping under jacket coping, being so constructed that it will preclude possibility of root fracture.

also be made without the use of any matrix material.

If the dentin of a fractured tooth is healthy, this structure is used for retention. (Figs. 6-7.) This inlay is really a section of a jacket crown. The lock in the dentin slopes at its incisal end and the floor of cavity also slopes parallel with the incisal slope, a depression of the floor resulting. This locks the inlay in posi-

tion, as previously mentioned under veneer crowns.

Many young people fracture the incisors during athletic activities, automobile accidents, etc. The dentist wishes to preserve as much natural tooth structure as possible and therefore does not resort to use of the entire veneer crown. The type of inlay shown in Figure 8 is permanent and esthetic. The planes on the floor of the cavity mesiad and distad from the

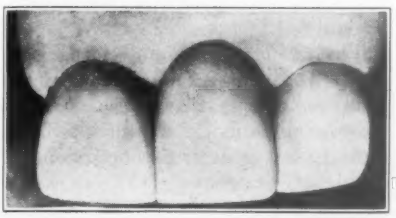

**Fig. 13.—Labial aspect of fixed bridge. The right central incisor is the major abutment; the left central incisor, the pontic.**

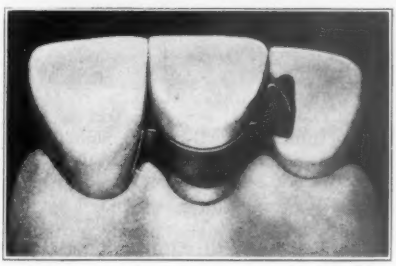

**Fig. 14.—Lingual aspect of fixed bridge showing right central incisor veneer crown abutment; left central incisor veneer pontic; gold inlay in mesioproximal side of left lateral incisor.**

pulp are inclined. The square cut in the lingual surface adds greatly to the thickness of the inlay because the tooth gets thicker in a labiolingual direction as it approaches the gingival margin. The enamel periphery is planed off to best withstand attrition, and the labial wall is longer than the lingual. It will be noted that all preparations are so engineered that they cannot be dislodged in the line of stress; e.g., during function. The operator should never rely on cement for retention, but only on form.

Occlusal porcelain inlays (Figs. 9-10) are practical. The matrix for this type of cavity is made in two pieces. One piece is adapted to the floor and one at right angles to the first; e.g., flat against the axial walls of the cavity. It is amazing how many wrinkles or folds in the matrix can be avoided at the cavosurface

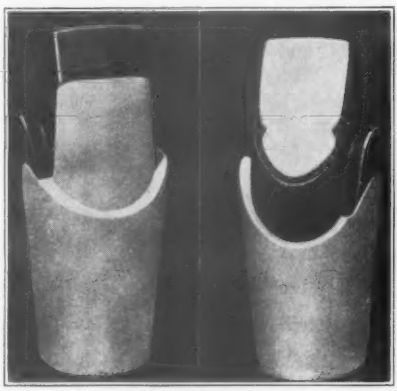

**Fig. 15.—Vital tooth preparation with gold casting showing depressed false shoulder. The false shoulder is in linguoproximal position and so is not visible from the labial aspect.**

angle, when this two-piece matrix is resorted to. After the matrix is swaged thoroughly and carefully, it is removed and filled about one third of its depth with porcelain and baked. Usually, the swaging will so closely adapt the two pieces of the matrix to each other that they will not separate in the baking. If the prosthodontist fears that they may separate, the matrix is filled with sticky wax before it is removed from the die

and after it is carefully adapted. In order not to distort the fit of the matrix at the cavosurface angle, a hole is drilled through the bottom of the amalgam die in the center of the floor. The matrix is then removed, being pushed out from the bottom with a thin instrument, the operator thus avoiding grasping the matrix at the well-fitting margin. The matrix is then invested in a suitable porcelain investment. The wax is then eliminated from the matrix and porcelain baked into it. After the first bake, the investment is removed from around the matrix. The porcelain now holds the matrix together. The matrix with the partly filled and underglazed porcelain is now replaced in the die and reswaged. Again, it is removed from the die with a thin instrument pushed up through the hole in the floor of the die, not to spoil the careful fitting of the matrix at the margins. The final bake is then consummated.

Fig. 16.—Labial aspect: Left to right: Gingival core porcelain inlay; completed cast gold pontic abutment; skeleton casting for abutment tooth; labial aspect of prepared vital tooth. The depressed shoulder is slightly wider than for the ordinary veneer crown.

A shoulderless molar veneer crown preparation with a gold coping into which is carved a false shoulder is shown in Figure 11. The axial sides of the casting engage the sides of the tooth and act as a definite seat for the casting, which is subsequently employed as a bridge abutment. Thus, a shoulder crown is obtained upon a shoulderless preparation. The gold coping, and not the jacket crown, is used as the bridge abutment.

A pulpless molar restored with a gold coping which is so constructed that it will preclude the possibility of root fracture, and may at the same time be used as an abutment for either a fixed or a removable type of bridge, is shown in Figure 12. The marginal bevel of the root periphery prevents the roots from separation or fracture and also assures a nonirritating gingival fit.

The mimicry of natural teeth, commonly known as staining of artificial teeth or altering of artificial teeth, a phase of ceramics, must be divided into three distinct groups: 1. The staining of manufactured teeth with base metal soldered in pins; e.g., denture teeth. 2. The staining of manufactured teeth that have no base metal pins, such as diatoric, Steele facings and "truebridge," and baked-in platinum teeth. 3. The staining of teeth of our own manufacture, such as jacket crowns and pontic blocks.

Fig. 17.—Lingual aspect: Left to right: aspect of prepared vital tooth; lingual metal frame cast in hard gold of skeleton three-quarter crown and pontic core; gingival porcelain inlay core.

Group 1. These teeth are already fused and glazed when we receive them and it is of great importance to remember that they contain soldered-in gold-plated base-metal pins. These pins are soldered to a little split cylinder of high fusing

precious metal. The solder used is a 14-carat gold solder, the melting point of which is 1600 F. If we attempt to stain these teeth with a stain of a higher fusing point than the melting point of the solder holding the pins to the baked-in precious metal cylinders, we are very liable to loosen the pins from their anchorage. If this condition remains undiscovered, it will lead to very embarrassing results after the denture is delivered.

Even though finely pulverized pumice may be worked between the pins and the porcelain with a fine explorer, and the lingual surface of the vulcanite tooth to be stained is covered with an investment material of high refractory qualities, the pins may be loosened from their anchorage because of the melting or crystallization of the 14-carat solder. Recently, there has been placed on the market a very low fusing stain employment of which will not cause loosening of solder around the pins, nor burn up the gold plating of the pins. The fusing point of this stain is 1400 F., which is 200 degrees lower than the melting point of the solder. This very suitable stain is known as Synlay stain. Stains fusing at 1600 F. may also be used with safety. A number of these stains should be mixed with glycerine and water, while others are applied to a glazed surface and mixed with water only. The darker shades, particularly those which can be used to imitate a leaky silicate filling, are more easily applied if glycerine and water in equal parts are used as a mixing medium. The glycerine and water of equal parts should be brought to the boiling point, but not a boil. By use of this medium, a thicker mix is obtained which is more easily controlled and will not run to other parts of the tooth. An artist's pen is used to apply the stain, rather than a fine brush. All stains must be covered with a colorless glaze after they have been applied and baked, so that they may remain permanent.

2. The Steele superglaze stains fusing at 1762 F. are very desirable for this purpose, and should be used as the manufacturer's directions dictate. They can be used on all pinless manufactured teeth or on teeth which are made with platinum pins. It is hoped that some of the important dental manufacturers will soon furnish a stain which has a sufficiently low fusing point that it may be universally applied to all manufactured teeth regardless of the particular method of pin attachment and construction.

3. When we stain teeth of our own manufacture, the problem of soldered-in pins does not present itself. Furthermore, we have a more accurate knowledge as to the fusing point of the porcelain. The fusing point of the porcelain of most of the manufactured teeth is between 2500 and 2600 F. Another point to be remembered is that manufactured teeth are a finished product when they reach our offices. If we wish to stain teeth of our own manufacture, we need not give them a surface stain, but can apply stain at any point during the construction, thus making a deeper shade with perhaps more desirable and lifelike effect. In these cases, a stain must be used of the same, or a similar, fusing point to that of the porcelain used in constructing the work at hand. High fusing stains should be used with high fusing porcelains, medium stains for medium porcelains and low fusing for low fusing porcelains.

In Groups 1 and 2, I apply a surface stain of low fusing character. In Group 3, I apply a deeper and more natural high fusing stain.

### ALL-PORCELAIN FIXED BRIDGE THAT IS REPARABLE IN THE MOUTH

It is my conviction that there is a place in restorative dentistry for all types and

kinds of bridgework for the replacement of missing teeth. The experienced clinician will carefully study each case as it presents itself, and select for his patient that particular type which, in his judgment, is most likely to give the desired results.

The bridge which is here described merely fills another niche in our knowledge of bridgework, and by familiarizing ourselves with it, we are prepared to employ it when those conditions present themselves where only it will assure the greatest possible number of advantages to the patient. When used with sound judgment, experience and skill, it will render most satisfactory service, and it is my conclusion that there is abundant use for this type of fixed bridge. As far as my knowledge is concerned, this type of bridgework has not previously been conceived. It contains a number of very desirable features, among which may briefly be mentioned: (1) absolute practicability, (2) versatility, (3) scientific correctness and (4) highest degree of esthetics.

Figures 13 and 14 show the labial and lingual aspects of an all-porcelain anterior bridge, which is supplying a missing left upper central incisor and utilizing a porcelain jacket or veneer crown over a vital right upper incisor as the major abutment. A small gold inlay in the mesiolingual surface of a left upper lateral incisor forms the minor or secondary abutment.

Figure 15 shows a typical jacket crown preparation of the abutment tooth with a well defined depressed shoulder. The shoulder is made but slightly wider than the average, but is deeper in an apical direction toward the core than it is at its periphery. When this preparation is completed, the tooth is prepared for the reception of an altered skeleton three-quarter crown casting. The gold casting preparation may be changed to meet various demands, and need not be followed dogmatically. For instance, the labio-incisal struss, or band, here shown may be placed labiogingivally, or the entire lingual surface may be covered with the casting, provided the bite will permit. It may also cover the entire conical part of the prepared tooth, but no matter which type is used, it must always be cast in the hard casting gold. It is assumed that this particular abutment tooth is a carious one and requires a jacket crown for its preservation regardless of the fact that it is needed as an abutment. Were this not the fact, some other form of abutment preparation which does not require so much tooth destruction should be selected. This system of fixed bridgework is equally adaptable where gold inlays, three-quarter crowns or gold jackets form the abutments. Assuming that a tooth is carious, it is logical that there may be proximal cavities, which may or may not have been previously filled.

These cavities are utilized to form the vertical strusses of the three-quarter casting by cutting two parallel channels at their labial and lingual margins with a No. 700 cross-cut fissure bur. It will be noted that the shoulder of the abutment tooth is depressed and is deeper in an apical direction nearest to the core than it is at its periphery, an acute angle to the core thus being formed. Should we not wish to make these slices, we can cover the entire tooth core with a casting, making it a thimble crown. There are endless varieties that one may employ to best suit the needs at hand. In no event does the gold casting cover the entire width of the shoulder, for the outer part, or periphery, of the shoulder is to be engaged by porcelain only, so that highly glazed porcelain, and not gold, comes in contact with the delicate gingival tissues.

### PROSTHETIC PROCEDURE

The amalgam die of the abutment tooth now being ready, we proceed to wax up the three-quarter casting, or thimble, or to follow whichever other technic we may have decided to employ in constructing it. A false shoulder is now added on the side approximating the edentulous space, linguoproximally so that the jacket crown, when in position, will make the gold invisible from the labial aspect. Should there be an edentulous space on each side of the abutment tooth, a false shoulder is added on each proximal side, care being taken to depress the false shoulder at an acute angle similarly to the shoulder on the natural tooth.

Where conditions are favorable, it is not essential to prepare a shoulder at all on the lingual surface; in which event, a false shoulder is built up in the casting wax extending over the entire lingual surface. This method has the advantage of not shortening the proximal side of the abutment porcelain jacket and adds to the surface contact subsequently to be soldered, but has the disadvantage of not putting porcelain in contact with the gum tissue at the lingual surface. This shortcoming is not more serious than that involved in using a three-quarter crown, and the jacket crown can often be made so as not to extend below the free margin of the gum.

After it is completed, the casting is tried in the mouth, together with any other abutment casting which may form part of the bridge, and a plaster impression and bite are obtained, together with the proper shade.

The amalgam die, or dies, are inserted with their proper gold abutments in the plaster impression and the model obtained, on which the bridge is to be constructed. (Figs. 16-17.) Usually, the first thing to be made is the gingival porcelain core, which will form the gingival part of the pontic tooth. This core may be constructed by baking as a porcelain inlay on a platinum matrix. It can also be ground from a sanitary pontic with its backing where the bite permits, and the gingiva gives sufficient room; or it can also be made from a manufactured tooth and ground to its desired shape.

### REPAIR OF BRIDGE

Just before the case is cemented into the mouth, individual modeling compound impressions are taken of all the pontic cores upon which jacket crowns have been fitted, together with all the abutment amalgam dies with their respective gold castings on them. An index may also be made. The modeling compound impressions are packed in amalgam and the resulting dies are filed. If, at any subsequent time, the patient should break any one of the jackets, abutment or pontic, they can be duplicated in a few hours and replaced. Thus, this type of bridge is reparable and therefore very practical.

### CONCLUSION

The foregoing is a brief survey of part of the field of dental ceramics. For the sake of brevity, many important uses of ceramics have been entirely omitted. The description of technical steps has been purposely described briefly in order to cover as much subject matter as possible in the least time. I have avoided theoretical procedures, limiting myself to those phases of ceramics which, in my hands, have proved eminently practical and of distinct permanent value to my patients. Many of the procedures described have been the result of careful thought and lengthy study in solving the problems which were forced on me by the demands of my patients.

576 Fifth Avenue.

# CARDIAC ARTERIOSCLEROSIS: WHAT IT MEANS TO THE DENTIST

By THOMAS B. HARTZELL, M.D., D.M.D., Minneapolis, Minn.

THIS brief article is offered to the dental profession in the hope that it may give cheer to many. The desire to make this contribution has been impelled by the reading of an excellent article in the January number of THE JOURNAL.[1] I quote:

> But there has come to the consciousness of the medical profession in recent years, a condition known as spasm of the arterial walls as the result of vasomotor nerve stimulation. This, a result of our civilization, is exemplified most clearly in the high tensioned business man of today, laboring under the added economic burden arising from the depression. . . . There has appeared to be almost an epidemic of coronary artery disease, which, sad to say, has invaded the ranks of physicians and dentists. A fear of heart disease, a neurosis, in our professions would seem to be likely, so I will try briefly to reassure you. . . . Before publication of an article by James B. Herrick of Chicago, the condition known as coronary thrombosis was not recognized, except by the pathologist, as a frequent cause of sudden death.

It has long been known that the activity of skeletal and heart muscle is invariably accompanied by the production of an electrical current. If the activity of the skeletal muscle or the heart muscle is normal, the curve of production of electricity will have a characteristic form, from which there is no variation except when the muscle becomes damaged by some process. The physiologists were able to record the electrical activity of dogs' and frogs' hearts very soon after the discovery of this universal law of physiology. But it was not until about 1898 that Baylis and Starling, two English physiologists, were able to record, in a very satisfactory sort of way, the activities of the human heart muscle by attaching electrodes to the arms and feet of men and women and connecting these by wires to capillary electrometers. It was necessary to construct a much more sensitive instrument than had ever been used before and one which could follow very rapid changes in magnitude and direction of current if the electrical currents produced by the heart were to be made available for the study of disease of the heart.

In 1904, Willem Einthoven, professor of physiology at the University of Leyden, announced the invention of a new galvanometer which was so sensitive that it could show a current of one billionth of an ampere, and which could react to a constant electrical current within one hundredth of a second. At the same time, he announced that this instrument, the string galvanometer, was capable of recording accurately for study the electrical currents produced by the heart when the right and left arm, the right and left leg and the left arm and leg were successively connected up to the poles of this new galvanometer. This instrument, which he termed the

1. Holmes, Bayard: Cardiac Diseases and the Dentist, J.A.D.A., 23:118 (Jan.) 1936.

string galvanometer, soon came into general use in the study of heart disease. The curve of the electrical activity of the heart, which this instrument writes on a photographic paper, is termed the electrocardiogram.

The human electrocardiogram shows the following essential parts: A small P wave about 2 or 3 mm. high, which is representative of the activity of the auricles. This P wave is followed by a pause during which the shadow remains level with the zero line. During this period, the impulse to activity of the heart is passing down the bundle of His from the auricles and out into the ventricular musculature. When activity begins in the ventricular musculature, a high peak of from 1 to 2 millivolts, called the R wave, is recorded in the electrocardiogram. This is usually preceded by a small downward peak called the Q and is usually followed by another downward peak or trough called the S, so that the Q, R and S waves, or peaks, represent the onset of activity of the ventricular musculature. After the activity of the S wave, the curve levels off on the zero line for a few tenths of a second, after which a broad wave called the T wave is described. The activity of the heart begins with the QRS wave and ends after the T wave.

Changes in the activity of the auricles are shown by changes in the form, direction and size of the P wave. For example, in the condition known as auricular fibrillation, the most common form of arrhythmia, and perhaps in many ways the most serious one, the P wave disappears entirely and many little irregular waves called F waves are seen. In fact, sometimes there are no waves whatsoever preceding the QRS and T waves in auricular fibrillation. In paroxysmal tachycardia originating in the auricles, the P wave takes on a different shape, and one familiar with electrocardiograms can make the diagnosis from an observation of the electrocardiogram. Auricular flutter also has characteristic P waves, which differentiate it. Auricular extrasystoles are also shown by the electrocardiogram. In conditions of heart block, the electrocardiogram shows a P wave that is not followed in the normal time by QRS and T groups. The different forms of heart block can be accurately diagnosed by a study of the electrocardiogram. Extrasystoles of the ventricle are shown by the bizarre form of the QRS group. A diagnosis can be made as to whether an extrasystole begins in the right or the left ventricle. When difficulties in conduction are present in the conducting substance of the ventricles, bizarre types of QRS groups are recorded which the expert can analyze, from his analysis determining the site of disease in the ventricles. Today, perhaps the most important part of the electrocardiogram is the T wave, because it is this wave that is more commonly found to be changed in coronary arteriosclerosis than any of the other waves. In this disease of the heart, the voltage of the R may become reduced below the normal value, thus giving indication of the presence of this serious condition of the heart.

Coronary arteriosclerosis and hypertension are the most common causes of heart disease in America today. The great increase in heart disease that has taken place in the last twenty-five years is almost entirely due to coronary arteriosclerosis and hypertension. These forms of heart disease are not found, as a rule, among young people, but are very common after 45 or 50 years of age. Coronary arteriosclerosis, which is only arteriosclerosis of the vessels that supply the blood to the heart muscle, very frequently cannot be diagnosed by any

other means than by the electrocardiogram. Coronary arteriosclerosis does not manifest itself by murmurs as valvular disease of the heart does. A patient may have coronary arteriosclerosis with attacks of angina pectoris or without attacks of angina pectoris. The heart may fail insidiously and the only evidence of what is causing the heart disease may be found by the electrocardiogram. Not only do changes in the T wave indicate coronary arteriosclerosis, but, not infrequently, changes also in the form and size of the QRS group indicate coronary arteriosclerosis. Attacks of coronary thrombosis, a most serious consequence of coronary arteriosclerosis, may be diagnosed by taking an electrocardiogram and examining the record. This record will indicate approximately in which one of the three coronary arteries the thrombosis has taken place. During attacks of angina pectoris, the electrocardiogram may be seen to change its form, especially the T wave; and, after the attack is over, the T wave will come back to its previous form, provided the attack of angina pectoris was not due to coronary thrombosis.

It had been known for many years that theophyllin preparations tended to cause a diuresis, and it was known then, and has been since proved, by direct observation, that the vessels of the kidney are opened up by this drug and that, in consequence of the opening up of previously closed capillaries, the diuresis is brought about. It was later on discovered that theophyllin derivatives would dilate the vessels of the brain and the coronary arteries of the heart. Theophyllin derivatives are in general use today for the purpose of dilating the coronary vessels as much as is possible. When nitroglycerine and amyl nitrite are used to dilate the coronary vessels, they tend in addition to increase the work of the heart by increasing the stroke output, and, at the same time, they tend to decrease the work of the heart by lowering the blood pressure. But in lowering the diastolic blood pressure, they tend, by just this much, to reduce the flow of blood through the dilated coronaries. Theophyllin preparations do not increase the stroke output to any appreciable extent. As they do not tend to drop the diastolic blood pressure very much, the whole effect of the dilatation of the coronary vessels is made manifest as an equivalent increase in blood flow through the coronary vessels. Theophyllin preparations have not supplanted nitroglycerine and amyl nitrite in the treatment of coronary arterioclerosis, but they have unquestionably supplemented these drugs. Although coronary arteriosclerosis is often called angina pectoris, it should be pointed out and emphasized that one can have coronary arteriosclerosis that does not manifest itself by an attack of angina pectoris, but from which a man may die suddenly without warning, or he may insidiously develop heart failure with shortness of breath, pain in the upper abdomen and dropsy. Electrocardiograms will frequently give evidence of this disease before the tragic results. In this way, it is possible to know of the disease before its serious manifestations are apparent, and to carry out measures to prolong the life and activities of one suffering from this condition.

It has been proved by Frederick Smith, professor of medicine at the University of Iowa, that by perfusing the coronary arteries of a dog, with aminophyllin introduced into the circulation, 1 part in 50,000, the blood through the coronary arteries is increased 80 per cent. Also, when Dr. Smith ligated a large coronary artery and thereby produced infarction of the heart muscle, he noted that, on putting aminophyllin in the coro-

nary circulation, the cyanotic infarcted area became redder; which showed that blood was getting into the area through the collateral vessels that had been opened up by the aminophyllin.

The lesson is just this: By the ingestion of a sufficient amount of aminophyllin to maintain a saturation of the blood to 1 part in 40,000 or 50,000, the heart itself is so well supplied with oxygen that life may be lengthened.

The deaths of Harding and of Coolidge, and, recently, the deaths of Wickersham and Curtis, were due to an insufficiency of the blood supply to the heart, and it is entirely possible that could they have had administered to them a sufficient amount of aminophyllin to maintain this necessary blood saturation, they might have lived many years. Comparatively few men understand this situation.

At my request, Prof. E. T. Bell, of the University of Minnesota, has just made a census of the hearts that we now have in our laboratory storage room. There are 1,400, 350 of which were obtained at postmortems on patients who died as a result of cardiac arteriosclerosis. Of this 350, a little over 15 per cent revealed blood clots or thrombosis. Since we know that blood can only clot when its movement becomes greatly slowed, I maintain had these persons had the help of aminophyllin, the blood clots could not have occurred. I have closely observed a case that illustrates my point. Three years ago, this person's heart blood supply as revealed by repeated electrocardiograms was just about two-fifths of normal. For the last year, the electrocardiogram proves the blood supply to the heart muscle itself to be a little better than normal as the result of maintaining a blood saturation with aminophyllin of 1 part in 40,000. Every person suffering from cardiac disease should be in the hands of a capable physician, one who thoroughly understands the facts revealed by an electrocardiogram. I could relate many cases of a return to and maintenance of health even more striking than the history just related, and I hope that this communication may result in the lengthening of many valuable lives.

In a recent lecture to a large group of men on the west coast, in which were many older men, I pointed out the value of aminophyllin. At that time, as far as I know, only Searle & Co., of Chicago, were producing it. I tried to emphasize the importance of the fact that it is not a habit-forming drug; that its influence existed only while in sufficient saturation and that if a person with a meager heart blood supply had the will to swallow enough aminophyllin every twenty-four hours, say in three-hour periods, during the time he was awake, he might live on for years, comfortably and free from all pain, and maintain a reasonable amount of physical activity. I pointed out the fact also that it was important to eat half as much and chew it twice as well, and the further fact that the body surface should be kept warm, because, when the body surfaces are cold, the capillaries close and increase unnecessarily the work of the heart.

# RELATION OF ORTHODONTIA TO OTHER FIELDS OF DENTISTRY*

By GEORGE R. MOORE, D.D.S., M.S., Ann Arbor, Mich.

PRIMITIVE medicine was unspecialized. The Greek physicians were laymen. They were artisans. The healing science was a craft. Even in Rome, where medical service was first introduced by Greek slaves, it was a generalized activity. This continued for nearly three centuries, more or less on a lay basis until, in 46 B.C., Julius Caesar presented all the Greek physicians who had settled on Roman soil with the freedom of the city of Rome. Privileges from then on became greater. Certain physicians were knighted. All were relieved of military service and taxation and of serving in office. This started the medical man up the social ladder and did much to make a profession out of what had once been one of the crafts. It was not until this time that in Rome specialization first appeared in medical practice.

So, in Imperial Rome, there came to be innumerable specialists. Certain doctors cared for only the ear, others the eye, others the teeth. Others treated only hernias, and others only bladder stones. Some physicians treated only with water and others only with wine.

Such specialism was then new to Rome, but history reveals that, 400 years prior to that time, Egypt was overrun with specialists, although, 2,000 years before, when Egyptian culture was at its peak, it is not known that there were specialists.

In the words of Sigerist, in "Man and Medicine":

> Specialism is a manifestation which develops in every cultural epoch as a natural necessity, always at a time when the culture has reached a certain age. The time always arrives when the extent of knowledge is so comprehensive and the methods so manifold that one person can no longer master the whole subject and the field of work must be divided.

Although dentistry was once one of the specialties of medicine, the necessity for specialization has proceeded to the point where dentistry is itself divided into many specialties. It is unnecessary to apprize any professional group today of the advantages or the disadvantages of specialism. Of its convenience, there is no doubt. That it extends the frontiers of special knowledge is an established fact. That it enhances the sum total of service to mankind, there is little doubt. Notwithstanding such advantages, it occurs to me that as individual specialists, we fall far short of what we could do to serve the public if we fail to pay the strictest attention to our relations with other specialists.

The term "orthodontist" should imply more or less extensive knowledge of periodontia, oral surgery, children's dentistry, crowns and bridgework and other partial prostheses. One must be to some extent a diagnostician in these other fields and must also understand their possibil-

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ities as to treatment. Technics of the other specialties may be interesting but relatively unimportant, although terminal possibilities of treatment in other fields must be well understood.

It is not enough to know, in a general way, that the orthodontist can often assist in perfecting the work of the oral surgeon and that oral surgeons can often materially assist during and after orthodontic treatment. What must be known is when and how. Such relationships of specialization must be seriously cultivated by every specialist. Certain men in our specialty whom I could name have worked hard in the study and furtherance of such relationships, but many of us do not begin to understand what is to be gained from them. No one field is self-sufficient. Orthodontics needs periodontics, but no more than periodontics needs orthodontics. Orthodontics needs partial prosthetics no more than partial prosthetics needs orthodontics.

I shall discuss separately the relations existing between orthodontics and the several other specialties of dentistry.

## ORAL SURGERY

Many cases belong purely to the field of oral surgery, just as many belong purely to the field of orthodontics, but there is a large group that demands close cooperation of the two specialties to obtain best results.

*Cleft Palate and Lip.*—This is perhaps the commonest major branch of oral surgery in which orthodontists and surgeons cooperate. Here, the premaxilla is the most troublesome feature in most cases in which there is a complete cleft of both lip and alveolar process, either single or double. Surgery made a distinct improvement in technic when it began to discard quite generally "bony union" as its aim in such cases. Flattening of upper lips and retrusion of the premaxillae with lingually posed and very irregular maxillary anterior teeth invariably resulted. Orthodontic treatment is nearly always necessary after any cleft lip operation, but if the cleft in the lip is surgically closed in the first few weeks of life and the natural pressure of the soft tissues of the lip is allowed to mold the bone gradually to its proper alinement until age 3 or 4 years, far less radical orthodontic interference will be necessary.

*Protrusion of Mandible.*—Here, the surgical technic employed depends not only on the peculiarities of the individual case but also on the peculiar wishes of the operator. A few operators section the mandible in the premolar region, sacrificing a tooth on each side and risking infection on account of exposure to intraoral contamination, but the majority of men select a more posterior site somewhere at the angle or in the ramus where horizontal resection and posterior shifting of the severed mandible into occlusion is possible. After interdental ligation or the use of splints for several weeks, minor orthodontic treatment completes the correction of these deformities.

*Open-Bite.*—This deformity is usually accompanied by an obtuse angle. It therefore would seem to lend itself best to resection of the mandible at the angle. Kostecka, of Prague, reports five cases in which he resorted to cutting through the rami from the sigmoid notch to the posterior border, thus avoiding long skin cuts and unsightly scars. After osteotomy, great force is often needed to push the mandible into its normal relations. It is then fixed for twelve weeks and minor orthodontic treatment may follow.

Modified applications of similar surgical principles are employed in the treatment of underdeveloped or extremely retruded mandibles.

Thus, it will be observed that the surgeon aids the orthodontist very materially

in assuring satisfactory results in many cases of extreme malformation of post-adolescence and that, in cleft palate and lip cases, the reverse is more likely to be the case. Here, the orthodontist is indispensable as an aid to the surgeon in successfully terminating the case.

One of the commonest misunderstandings that exist between oral surgeon and orthodontist has to do with the advisability of early removal of certain supernumerary teeth. It is sometimes difficult for the surgeon to see how urgent it is to remove such teeth before disproportion and maldistribution of the osseous structure is induced. Particularly is this true in the case of deeply embedded supernumerary teeth in the midsagittal plane of the maxilla. Early removal often eliminates the need for orthodontic treatment; whereas, delaying removal until conditions seem more suitable for the surgeon's work may involve much unnecessary orthodontic treatment to repair damage affecting the development of the region.

Cooperation is the rule between oral surgeon and orthodontist, especially in respect to occasional extraction of teeth in the adult, compromise cases of the orthodontist; the exposure of impacted cuspids to be brought into place by the orthodontist, and the extraction of third molars when deficiency of alveolar development seems to favor their removal. In all such cases, oral surgeons everywhere seem to be willing to concur in the wishes of the orthodontist, who, in turn, lends assistance in the partial or complete immobilization of the mandible by adjusting splints, headgear and arch sections with elastics or interdental ligatures, in subluxation of the temporomandibular articulation, fracture cases, extreme resection cases, etc. This combination of the diagnostic and therapeutic efforts of the two specialties has grown much in the past few years, but facial fracture cases are still too frequently regarded as purely surgical cases. The only way to insure the best possible occlusion in such cases is to consult the orthodontist at the time when the initial surgical work is being done. Not only can a previously normal occlusion be restored in many cases, but also, in a few previously malformed cases, correction of the malformation is not at all impracticable as a result of the accident, combined with its surgico-orthodontic treatment. I have seen deformities on the streets here today that nothing would improve so much as an automobile accident, provided it confined its effects to the face. This is incidentally an argument for making occluded models of every patient and keeping them indefinitely, to be referred to in case of fracture.

### PERIODONTIA

A relationship between specialties that is not cultivated to a sufficient degree is that between orthodontia and periodontia. Those who have studied it recognize its importance, notably Albert Ketcham and Henry Hoffman, who each reported their views in 1930 before the American Academy of Periodontology. In my opinion, cooperation between periodontist and orthodontist is less satisfactorily developed than our relationship with any other specialty. Hoffman names several types of malocclusion which induce periodontal disease: (1) the presence of a thin labial plate of alveolar process; for example, when a lower incisor occludes labially from its opponents; (2) extreme overbite impinging on tissues linguad from maxillary incisors, to which might be added those cases of overbite in which maxillary incisors impinge on tissues labiad from mandibular incisors; (3) distoclusion sometimes accompanied by lack of function of mucous membrane and con-

sequent hypertrophic gingivitis; (4) rotation of teeth, a common example of which is rotation of the lateral incisor or bicuspid; (5) spacing of the teeth; (6) retention of the deciduous molars when succeeding bicuspids are congenitally absent.

It is the periodontist's obligation to refer all such types of malocclusion to the orthodontist if he expects to free them of periodontal disease. The orthodontist sees many such cases in which he alone can remove the cause. He also sees cases of periodontal disease associated with malocclusion for which he should do nothing without first sending them to the periodontist. Ketcham lists in this group cases of gingivitis caused by the presence of (1) calcareous deposits and (2) rough enamel.

Still another group of cases in which malocclusion is associated with periodontal disease should go to the physician before treatment is administered by either orthodontist or periodontist. This group includes (1) cases of noninflammatory pyorrhea and (2) cases of gingivitis caused by faulty nutrition.

Hoffman also calls attention to the fact that orthodontic treatment sometimes leads to periodontal disease. This is especially true in adolescent and adult cases when occlusal relations that have been well established are suddenly changed. Old abraded facets on the surfaces of opposing teeth no longer occlude. The periodontist should be given an opportunity after orthodontic treatment to correct such conditions by trimming the gums systematically to avoid undue trauma to the supporting tissues. Mild malrelations between occlusal surfaces soon adjust themselves in the healthy individual without such trimming. If there is widespread evidence throughout the mouth of periodontal disease following orthodontic treatment, radical trimming of occlusal surfaces is contra-indicated. Such patients are obviously suffering from general debility, which should be referred to the physician. No amount of sacrifice of tooth substance will correct the condition. Ketcham refers to the impacted third molar as being related to both periodontics and orthodontics. Its presence not only disturbs occlusal relations, but also produces trauma and pocket formation. Extraction is indicated in known cases of impaction, but care must be taken to diagnose the condition accurately by means of roentgenograms from more than one angle. Not all third molars are really impacted which appear to be so on the first roentgenographic examination. Moreover, periodontal lesions may occur in the third molar region without impaction of the third molar. Periodontal treatment, not extraction, is indicated in such cases.

Patients vary in susceptibility to gingival irritation arising from a faulty orthodontic technic. This fact does not excuse the orthodontist for placement of poorly fitted bands and unnecessarily bulky and unhygienic appliances even in the least sensitive mouths. Periodontists whose patients are being abused by such orthodontic work should give a word of advice to the orthodontist. A freer interchange of ideas is indicated between orthodontist and periodontist.

### DENTAL PROSTHESIS

Dental prosthesis deals with the construction of artificial substitutes, including full dentures, partial dentures and all forms of bridgework. The thought of preparing an orthodontic patient for full denture service may at first appear ridiculous, but one of the important indications for orthodontic treatment of malrelation of the dental arches is based on the extremely unsatisfactory prognosis of such cases in the hands of the full denture

prosthetist late in the patient's life. Denture trouble will be averted by timely orthodontic treatment.

In one case, in a patient, aged 43, for whom full upper and partial lower dentures were planned, all the maxillary teeth and the mandibular incisors were extremely pyorrheic, extraction being indicated. The mandibular left first and second bicuspids were tipped at a 45 degree angle lingually, but were sound teeth and would be an aid in partial denture service. The mandibular molars were also sound. Extraction of the maxillary teeth was deferred and a modified upper Hawley retainer with inclined plane anteriorly was used as a splint to hold the bite open until the mandibular bicuspids were tipped into line. The lower partial denture was then constructed, after which the maxillary teeth were extracted and an immediate upper full denture was supplied.

Consultation between orthodontist and prosthodontist on this case took place before the denture service was planned. Too often, such a case would not be seen by the orthodontist until all pyorrheic teeth had been extracted, the case being then more difficult for the orthodontist and more radical for the patient.

Partial denture service is closely related to orthodontics in that every partial denture or removable bridge is a potential orthodontic appliance. Abutment teeth shift under or in other ways respond to the application of load. The orthodontist should be able frequently to assist in solving unusual problems pertaining to this field. Partially edentulous orthodontic cases must usually rely on partial dentures, removable or fixed bridges, for permanent maintenance of space and restoration of function. All prosthetic work in such cases must be constructed with a full understanding of the orthodontic work previously terminated, and this can be gained only through close cooperation between the two specialties.

Many excellent orthodontic end-results in cleft palate and lip cases have been reported in the literature. In some of these, perhaps orthodontics was the only possible form of satisfactory treatment, this warranting its maintenance from eight to twelve years in some cases. In other cases, on account of the orthodontist's jealous interest in the mechanics of his treatment, patients have been led to believe that orthodontic treatment was the only solution, when a little orthodontics and much more prosthetics would have been quite as satisfactory and much less troublesome to the patient. In such cases, the zealous orthodontist is sometimes guilty of administering treatment that is worse than the condition he is treating. In general, the extreme cleft cases lend themselves better, I believe, to a combination of orthodontic and prosthetic service than to an overdose of either one.

Years ago, the belief was universal that orthodontic treatment could not be successfully administered in adult cases. The widespread continuance of this belief somewhat impedes cooperation between orthodontist and prosthetist. As a matter of fact, minor shifting of teeth to meet the requirements of bridgework can be carried out at almost any age at which the bridgework itself would be considered practicable.

### GENERAL DENTISTRY, OPERATIVE DENTISTRY AND CHILDREN'S DENTISTRY

A few years ago, I made the statement that "at present, preventive orthodontics, so-called, is largely in the hands of the operative dentist." The situation is the same now if we also include in the ranks of operative dentistry that rapidly growing group of men who devote their time to children's dentistry. This work differs from other phases of operative

dentistry only in the fact that a somewhat different application of certain mechanical and psychologic technics is necessary by reason of the nature of the patients handled. It is pursued as a specialty principally by men who are already well fitted temperamentally to manage child patients or are willing to train themselves for the task. They share with the general and operative dentist the bulk of responsibility for prevention of malocclusion, since their advice is generally sought first.

Preventive orthodontics implies (1) a sufficient general knowledge of the processes of growth and development to detect the onset of unsatisfactory developmental changes as such, even though their diagnoses may not be clearly understood; (2) proper care of the deciduous and the permanent dentition with regard for tooth form; (3) extraction of deciduous teeth at the proper time; (4) the use of space maintainers if necessary; (5) reference of patients for treatment at the proper time.

Relations between the orthodontist and the general dentist are not ideal. If they were, we would not see 30 or 40 per cent of those needing orthodontic treatment going without it. The fact is that the average general dentist knows too little about the orthodontic specialty. As most conditions treated in the field of operative dentistry are diagnosed with the patient's mouth open, many patients come into the office and leave without being asked to close their mouths long enough to have the occlusion examined thoroughly. It should not be forgotten that the patient who is allowed to remain in ignorance of the need for orthodontic treatment until it is too late for correction is often vindictive when the true status of the case is learned. The blame rests entirely on the dentist who has had the care of the child. The dentist should pass the responsibility for diagnosis on to the orthodontist in these cases. He will then, regardless of the orthodontic advice received, be given credit for doing everything possible for the patient's well-being. There is, moreover, a right and wrong way to refer patients. I can nearly always tell who has referred the patient by the parents' attitude during the consultation. Some come in with fear and trembling after the dentist has told them his idea of what will have to be done or what the treatment will cost. Others have been told how simple it will be and how little it will cost. Such preliminary remarks by the dentist are misleading. It is far better to leave all discussion of fees and methods to the orthodontist, telling the patient that you have recognized what you think may be an abnormal condition but that you want the orthodontist's opinion as to what should be done.

Some patients have been watched by the dentist through the entire transition period, because he had an idea that the condition would right itself. Responsibility should have been shifted to the orthodontist, perhaps years before; in which event, treatment might have been entirely or almost entirely avoided.

On the other hand, the general practitioner could undoubtedly compile a long list of responsibilities not well assumed by his orthodontic friends. When the orthodontist accepts a patient for treatment, he assumes responsibilities not only to the patient, but also to the dentist who referred him: 1. He must watch closely for caries, and if it is present, should refer the patient back immediately to the dentist, with a simple reference to the fact that caries is present. The patient should always be informed that there may be other teeth that are carious and that if there are, the dentist will fill them. 2. He must closely observe the condition of the gingivae. 3. He should

recement bands at four to eight month intervals, this depending on the degree of the patient's susceptibility to caries. 4. He should follow up cases by conferring with dentists concerning patients still going to them long after dismissal by him.

The orthodontist can learn much from the observing general practitioner who follows cases for a lifetime and is often able to render valuable opinions based on long-time observation. The true end-results of orthodontic treatment are more likely to be seen by him than by the orthodontist.

In calling attention to the foregoing practical relations that should exist between the orthodontist and the other dental specialties, I have endeavored to demonstrate three important facts concerning specialization:

1. It develops not by accident, but by necessity, as a result of increase in the scope of dental science.

2. It brings with it the danger of forgetting that one is dealing with the whole individual.

3. The cultivation of practical relationships between specialties as indicated in this paper is the most effective means of combating such dangers of specialization.

# RELATIONSHIP OF HYDROGEN ION CONCENTRATION TO THE EFFICIENCY AND TOXICITY OF LOCAL ANESTHETIC SOLUTIONS*

By C. D. GWINN and E. W. FERBER, San Francisco, Calif.

MANY articles have appeared in both American and foreign journals during the past few years concerning the changes in action of certain local anesthetics on the addition of alkali to their solutions. The most notable work pertaining to dentistry is that of Benedict,[1] Freeman,[2] Dailey[3] and others at Northwestern University during the years 1929-1932.

They found that when weak alkali salts, such as sodium carbonate, secondary sodium phosphate or potassium carbonate, were added to the usual anesthetic solution (procaine hydrochloride plus epinephrine chloride in normal saline or distilled water), their action clinically and on experimental animals became much more rapid. They checked the $p_H$ of their anesthetic solutions against the time for anesthesia to appear and found that as the $p_H$ became higher, the onset of anesthesia became more rapid. They[4] found that there was less pain following injections in the mouth with the alkaline solutions than with the ordinary acid solutions commonly in use. Similar results have been obtained by Harvey[5] and

*Read before the Research Section of the California State Dental Association, Oakland, Calif., April 8, 1935.

1. Dailey, H. T., and Benedict, H. C.: D. Cosmos, 71:704 (July) 1929.

2. Freeman, C. W.: D. Cosmos, 71:949 (Oct.) 1929. Freeman, C. W., and Benedict, H. C.: Bull. Chicago D. Soc., 10:3 (Aug. 8) 1930.

3. Dailey, H. T.: D. Cosmos, 71:945 (Oct.) 1929.

4. Footnote 2, second reference.

5. Harvey, H. C.; De Ford, C. C., and Eller, C. C.: D. Cosmos, 74:592 (June) 1932.

TABLE 1.—HYDROGEN ION CONCENTRATION

| *p*H Values | | Acid and Alkali Normalities | Fractional Values in Grams per Liter of Hydrogen Ions | Decimal Values in Grams per Liter of Hydrogen Ions |
|---|---|---|---|---|
| Acid | 0 | $\frac{N}{1}$ | 1 | 1 |
| | 1 | $\frac{N}{10}$ | $\frac{1}{10}$ | 0.1 |
| | 2 | $\frac{N}{100}$ | $\frac{1}{100}$ | 0.01 |
| | 3 | $\frac{N}{1000}$ | $\frac{1}{1000}$ | 0.001 |
| | 4 | $\frac{N}{10000}$ | $\frac{1}{10000}$ | 0.0001 |
| | 5 | $\frac{N}{100000}$ | $\frac{1}{100000}$ | 0.00001 |
| | 6 | $\frac{N}{1000000}$ | $\frac{1}{1000000}$ | 0.000001 |
| Neutral | 7 | $\frac{N}{10000000}$ | $\frac{1}{10000000}$ | 0.0000001 |
| Alkaline | 8 | $\frac{N}{1000000}$ | $\frac{1}{100000000}$ | 0.00000001 |
| | 9 | $\frac{N}{100000}$ | $\frac{1}{1000000000}$ | 0.000000001 |
| | 10 | $\frac{N}{10000}$ | $\frac{1}{10000000000}$ | 0.0000000001 |
| | 11 | $\frac{N}{1000}$ | $\frac{1}{100000000000}$ | 0.00000000001 |
| | 12 | $\frac{N}{100}$ | $\frac{1}{1000000000000}$ | 0.000000000001 |
| | 13 | $\frac{N}{10}$ | $\frac{1}{10000000000000}$ | 0.0000000000001 |
| | 14 | $\frac{N}{1}$ | $\frac{1}{100000000000000}$ | 0.00000000000001 |

Fischer.[6] They found their percentage of failure in the clinic to be at least as low with the alkaline as with the acid solution. They used[7] a solution of procaine borate which is quite alkaline in reaction and found it to have a very rapid action in spite of the fact that the molecule contained little over half as much active procaine base as the hydrochloride. Their work along these lines suggested further studies and it was with this in mind that our work was started.

The laboratory work reported in this paper was done at the George William Hooper Foundation, the Department of Pharmacology, and the College of Dentistry, University of California under a research grant from the college of dentistry. Especial thanks are due Karl F. Meyer, Chauncey Leake, John A. Marshall and Mr. C. F. Allen for valuable advice and for the use of laboratories and equipment.

Before describing the experiments performed, it may be well to briefly discuss hydrogen ion concentration as a measure of acidity and alkalinity. The following explanation is taken from "Pathogenic Microorganisms."[8]

When an acid, base or salt goes into solution, some of it remains in the form of molecules, while other molecules are split into two parts, positive ions carrying a positive charge and negative ions carrying a negative charge of electricity. In acids, it is the predominance of the positive hydrogen ions that give them their sour taste and other acid properties. Pure water ionizes and contains both positive hydrogen ions and negative hydroxyl ions, which neutralize each other. If to pure water, a drop of hydrochloric acid is added, a mixture containing hydrogen ions, hydroxyl ions and chlorine ions, besides the molecules of water itself, results. The number of free hydrogen ions is greatly increased because hydrochloric acid dissociates or ionizes al-

Table 2.—Data on Fish Experiment

| Sodium Carbonate per Liter | Procaine Hydrochloric Acid per Liter | *p*H | Average Anesthesia Time Seconds | No. Fish |
|---|---|---|---|---|
| 0.3 | 0.5 | 8.97 | 75.2 | 25 |
| 0.3 | 2.5 | 8.45 | 47.4 | 25 |
| 0.3 | 4.5 | 8.26 | 41.1 | 25 |

Table 3.—Data on Fish Experiment

| Sodium Carbonate per Liter | Procaine Hydrochloric Acid per Liter | *p*H | Average Anesthesia Time Seconds | No. Fish |
|---|---|---|---|---|
| 0.1 | 2.0 | 7.96 | 212.5 | 25 |
| 0.2 | 2.0 | 8.30 | 84.0 | 30 |
| 0.3 | 2.0 | 8.45 | 42.0 | 68 |

6. Fischer, Guido: Local Anesthesia in Dentistry, Philadelphia: Lea & Febiger, 1933, pp. 33-47.

7. Footnote 2, first reference.

8. Park, W. H.; Williams, A. W., and Krumwiede, Charles: Pathogenic Microorganisms, Ed. 10, Philadelphia: Lea & Febiger, 1924, p. 101.

most completely and the drop of hydrochloric acid contains a large number of them. The number of hydroxyl ions is decreased because the change in ionic equilibrium caused many to combine with free hydrogen ions to form water. If a base is added to water or other neutral solution, the relation is reversed. Either the hydrogen ion concentration or the concentration is an index to their several strengths.

Pure water contains 0.0000001 gm. hydrogen ions per liter and is taken as the neutral point. As it is unwieldy to write such fractions, Sorenson suggested using the exponent of the logarithm to express the hydrogen ion concentration. Water having 0.0000001 gm. hydrogen ions per liter, or $1\times10^{-7}$ is listed as 7, the neutral point. A normal solution of acid which would contain 1 gm. hydrogen ions per liter and which would ionize 100 per cent would have a $p_H$ of 0, the logarithm of 1 being 0. As the logarithmic scale goes by tens, a tenth normal solution would have a $p_H$ of 1, and so on. A normal solution of alkali hydroxyl concentration may be used as an index, but it is customary to use the hydrogen ion concentration which is inversely proportional to the dissociation of the base and therefore to the true alkaline reaction of the solution.

Different acids and bases ionize to different degrees and, when dissolved in water in like amounts, the hydrogen ion

Table 4.—Data on Fish Experiment

| | $p_H$ | No. Fish | Average Time Seconds |
|---|---|---|---|
| Procaine borate 2 gm. per liter distilled water | 8.36 | 150 | 74.0 |
| Procaine base 1 gm. per liter | 8.84 | 50 | 55.5 |
| After boiling | 8.45 | 3 | 130.0 |

Table 5.—Data on Frog Experiment

| | $p_H$ | No. Frogs | Average Time Minutes |
|---|---|---|---|
| Procaine-hydrochloric acid 1 per cent in distilled water | 6.08 | 6 | 9.1 |
| Procaine 1 per cent in sodium carbonate solution 0.1 gm. per liter | 7.35 | 4 | 5.1 |
| Procaine-hydrochloric acid 1 per cent in sodium carbonate solution 0.2 gm. per liter | 7.65 | 5 | 2.9 |
| Procaine-hydrochloric acid 1 per cent in sodium carbonate solution 0.3 gm. per liter | 7.78 | 4 | 2.1 |
| Procaine-hydrochloric acid 1 per cent in sodium carbonate 0.4 gm. per liter | 7.96 | 4 | 2.4 |
| Procaine base 1.0 gm. per liter | 8.84 | 4 | 7.5 |

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most completely and the drop of hydrochloric acid contains a large number of them. The number of hydroxyl ions is decreased because the change in ionic equilibrium caused many to combine with free hydrogen ions to form water. If a base is added to water or other neutral solution, the relation is reversed. Either the hydrogen ion concentration or the concentration is an index to their several strengths.

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| Procaine-hydrochloric acid 1 per cent in sodium carbonate solution 0.3 gm. per liter | 7.78 | 4 | 2.1 |
| Procaine-hydrochloric acid 1 per cent in sodium carbonate 0.4 gm. per liter | 7.96 | 4 | 2.4 |
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hydroxyl concentration may be used as an index, but it is customary to use the hydrogen ion concentration which is inversely proportional to the dissociation of the base and therefore to the true alkaline reaction of the solution.

Different acids and bases ionize to different degrees and, when dissolved in water in like amounts, the hydrogen ion gm. hydrogen ions per liter, or $1\times10^{-7}$ is listed as 7, the neutral point. A normal solution of acid which would contain 1 gm. hydrogen ions per liter and which would ionize 100 per cent would have a $p_H$ of 0, the logarithm of 1 being 0. As the logarithmic scale goes by tens, a tenth normal solution would have a $p_H$ of 1, and so on. A normal solution of alkali

also completely dissociated would have a $p_H$ of 14. The strengths of acids and bases that may be expressed in the $p_H$ scale cover the range of fluids of the body.

There are two methods used in determining hydrogen ion concentration, the colorimetric and the electrometric. The latter, by far the more accurate, was the method used by us. A Leeds and Northrup type K potentiometer and quin hydrone electrode were used in all of our determinations.

Alkaline anesthetic solutions are not new. Gros,[9] in 1912, used procaine borate, bicarbonate and secondary phosphate on the sciatic nerves of frogs and found that a more rapid and more prolonged anesthesia resulted from the use of procaine hydrochloride in equal concentration. He also noticed that the addition of sodium bicarbonate in 0.7 per cent sodium chloride solution to procaine hydrochloride greatly reduced the time required for anesthesia to appear. Sollman[10] found that the action of procaine hydrochloride solution on the exposed sciatic (motor) nerve of the frog was increased eight times by the addition of 0.1 per cent sodium bicarbonate or m sodium acid phosphate. On the sciatic plexus (sensory) of frogs, the addition of 0.5 per cent sodium bicarbonate increased the efficiency of procaine hydrochloride from two to four times.[11] On the skin of frogs, the addition of sodium bicarbonate to the procaine hydrochloride solution increased the efficiency from four to eight times.[12] On the rabbit's cornea,[13] the addition of 0.25 per cent sodium bicarbonate to the procaine hydrochloride solution increased the efficiency from two to four times.

Sollman[14] found that the addition of 0.25 per cent sodium bicarbonate to the procaine hydrochloride solution decreased

TABLE 6.—TWO PER CENT PROCAINE-HYDROCHLORIC ACID, EPINEPHRINE 1:50,000, SODIUM CARBONATE, 0.3 GM. PER LITER DISTILLED WATER

| Injection | Number | Amount Injected | Average Anesthetic Time | Failures |
|---|---|---|---|---|
| Mandibular | 194 | 3 c.c. | 2.8 minutes | 10.8 per cent |
| Infiltration | 42 | 2.5 c.c. | 2.3 minutes | 2 per cent |

TABLE 7.—TWO PER CENT PROCAINE-HYDROCHLORIC ACID, EPINEPHRINE 1:50,000, SODIUM CARBONATE, 0.3 GM. PER LITER DISTILLED WATER

| Injection | Number | Amount Injected | Average Anesthetic Time | Failures |
|---|---|---|---|---|
| Mandibular | 175 | 3 c.c. | 3.7 minutes | 10.2 per cent |
| Infiltration | 65 | 2.5 c.c. | 1.1 minutes | 7.5 per cent |

9. Gros, O.: Arch. Exper. Path. & Pharmacol., 67:132, 1912.

10. Sollman, Torald: J. Pharmacol. & Exper. Therap., 10:379, 1917.

11. Sollman, Torald: J. Pharmacol. & Exper. Therap., 11:1-26, 69-80 (Feb.) 1918.

12. Footnote 11, page 17.

13. Footnote 11, page 69.

14. Footnote 11, page 75.

the efficiency in injection subcutaneously in human beings. He therefore concludes that it would not be useful in intracutaneous injections. Meeker[15] found that the addition of 2 per cent sodium bicarbonate to 2 per cent procaine hydrochloride solution produced satisfactory anesthesia in the rabbit's cornea; while 4 per cent procaine hydrochloride used alone produced no anesthesia. On wheals raised on the human skin, he found no increase in the potency of procaine on the addition of alkali. Gerlough's results[16] on the rabbit's cornea were in accord with those of Meeker. Osterberg[17] feels that for injection purposes, when alkaline buffered tissue fluids are encountered, the addition of alkali to the anesthetic solution is of no material help.

TABLE 8.—THREE PER CENT PROCAINE-HYDROCHLORIDE

| Mg./Kg. | Number Animals Used | Lived | Died |
|---|---|---|---|
| 200 | 5 | 5 | 0 |
| 300 | 5 | 5 | 0 |
| 400 | 5 | 5 | 0 |
| 500 | 5 | 4 | 1 |
| 600 | 4 | 3 | 1 |
| 700 | 5 | 0 | 5 |

The experimental animals used by Benedict and others were the common gold fish of from 2 to 4 gm. They were used to measure onset or speed of anesthesia. In our work, we have used the gold fish and the frog to measure the difference in onset of anesthesia, and albino mice and cats to measure the toxicity of the solutions. The gold fish had been used by several previous investigators. Shellford used them to test water pollution. Powers[18] used them to test the toxicity of certain drugs. Adams[19] employed them to test a number of anesthetic compounds. Fosdick[20] used them to study the variation of anesthetic efficiency of procaine hydrochloride and procaine borate with $p_H$. Macht[21] used them to test the anesthetic efficiency of a number of isomeric octyl alcohols. All of these writers concluded that the common gold fish was extremely sensitive to slight variations of poisonous and anesthetic compounds.

The method of testing with the gold fish used by us was that described by Dailey and Benedict, with some slight modifications.

The fish were kept in tanks at a temperature of 20±1 C. and not fed for twenty-four hours before being used. Slight variation in temperature caused a marked difference in anesthesia time. We were able to confirm this observation of Powers[18] and Dailey.[1] The fish were

TABLE 9.—THREE PER CENT PROCAINE-HYDROCHLORIDE, 0.4 GM. SODIUM CARBONATE PER LITER

| Mg./Kg. | Number Animals Used | Lived | Died |
|---|---|---|---|
| 200 | 5 | 5 | 0 |
| 300 | 5 | 5 | 0 |
| 400 | 5 | 2 | 3 |
| 500 | 5 | 3 | 2 |
| 600 | 5 | 0 | 5 |
| 700 | 5 | 0 | 5 |

15. Meeker, W. R.: J. Lab. & Clin. Med., 11:139 (Nov.) 1925.

16. Gerlough, T. D.: J. Pharmacol. & Exper. Therap., 41:307 (March) 1931.

17. Osterberg, A. E.: Brit. J. Anesth., 6:29 (July) 1928.

18. Powers: Illinois Biog. Monographs, Vol. 4, No. 2, 1917.

19. Adams, R., et al.: J. Am. Chem. Soc., 48:1758, 1926.

20. Fosdick, L. S.; Hansen, H. L., and Dragstedt, C. A.: Proc. Soc. Exper. Biol. & Med., 27:529 (March) 1930.

21. Macht, D. I., and Leach, Harriet: J. Pharmacol. & Exper. Therap., 39:71 (Feb.) 1930.

placed one at a time in 600 c.c. beakers containing 200 c.c. of the solution to be tested. This beaker was suspended in the tank while the test was being carried on so that the temperature would remain the same. Three fish were used before changing the solution in the beaker.

The drugs were weighed on an analytic balance and the solutions made up in volumetric flasks. The fish were weighed on a laboratory scale accurate to within 0.5 gm.

Local anesthetics in solution affect gold fish as general anesthetics. The fish exhibit symptoms in three stages: (1) violent pounding against the sides of the beaker, (2) quiet but still reacting to stimuli such as pinching of the tail and (3) loss of mouth and fin motion and no response to pressure on the tail or against the body. The time for anesthesia was taken from the introduction of the fish into the solution until mouth and fin motion were lost and the fish no longer responded to pressure against the tail or side of the body. Results were averaged and recorded. The fish were handled in nets to avoid possible contamination from the hands and were used once only.

Having decided to use sodium carbonate as the alkali salt, we placed a number of fish in a solution containing 0.3 gm. sodium carbonate per liter of distilled water. After an hour, they were swimming about actively and showed no ill effects from the action of the sodium carbonate. We then repeated this procedure, using a solution of procaine hydrochloride containing 2 gm. per liter of distilled water. After an hour, the fish were apparently normal and showed no signs of anesthesia. When fish were

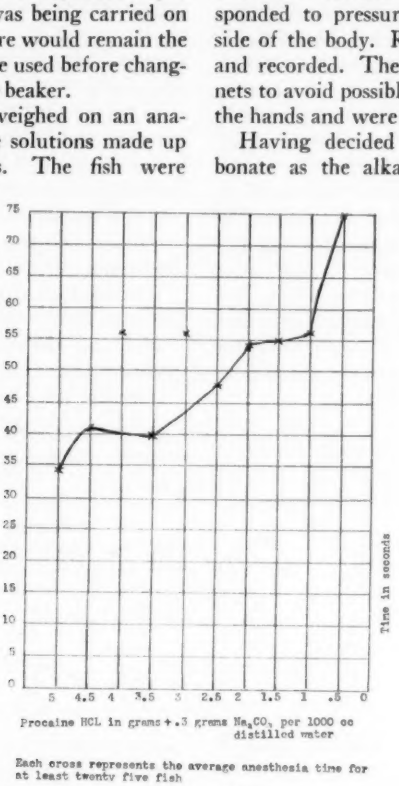


Figure 1.

placed in a beaker containing a mixture of equal parts of the foregoing solutions, they were anesthetized within ninety seconds. Evidently, some change had taken place in the mixture that affected the fish very powerfully. It was not the hydrogen ion concentration because, in the case of the straight sodium carbonate solution, the $p_H$ was 9.04—strongly alkaline—and, in the case of the procaine hydrochloride, the $p_H$ was 5.68—quite acid.

In procaine hydrochloride solutions in very slightly soluble in water, unstable in solution and having a $p_H$ of 8.8 when 1 gm. is dissolved in 1,000 c.c. of distilled water. In this solution, the average time for anesthetizing twenty-five fish was fifty-five seconds. As you will note from the tables, this time compares with that obtained by 2 gm. of procaine hydrochloride dissolved in distilled water containing 0.3 gm. of sodium carbonate per liter.

Procaine borate was tried because it is

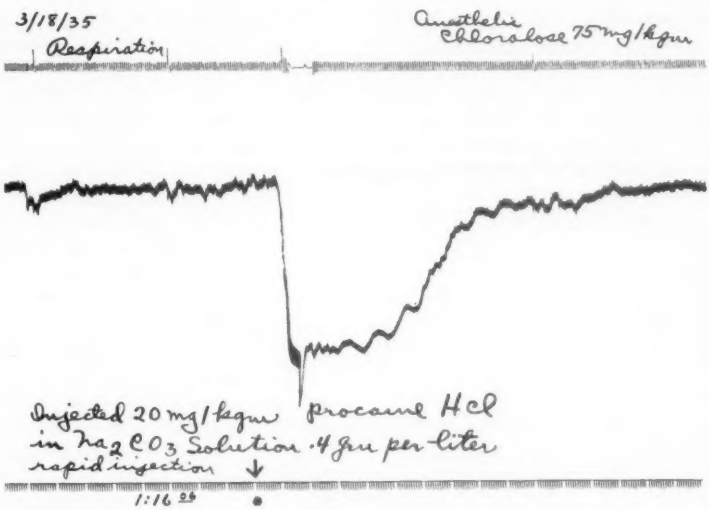


Figure 2.

distilled water, the main change that takes place as alkali is added and the $p_H$ rises is the freeing of a larger quantity of the free procaine base.[16] It seemed, therefore, to us, as it had to a number of previous investigators, that the rapidity of anesthesia depended to some extent at least on the amount of the free anesthesic base present in the solution.

Through the courtesy of Dr. Volwiler of the Abbott laboratories, we obtained a quantity of procaine base, a white powder a combination of the base with a weak acid, and it is known that there is a good deal of the free base present in its solutions. It anesthetized the fish rapidly although, molecule for molecule, it contains only slightly more than half the amount of procaine base as the hydrochloride. More than a thousand fish experiments were performed; the strength of procaine and sodium carbonate being varied. Some of the results are shown in the accompanying tables.

Most of the fish anesthetized recovered in from one half hour to one hour after removal from the solution. The fish that were anesthetized most quickly recovered in the shortest time. This held true in the case of all the solutions used. There has been some criticism concerning the use of gold fish to test anesthetic solutions on the grounds that it was merely the toxicity that was being demonstrated. It has been our experience that the shorter the anesthesia time, the shorter the recovery time. It does not seem reasonable that the most toxic drug, i.e., that drug which would anesthetize the fish most quickly, would be the drug that would allow of the quickest recoveries and the fewest fatalities. It seems, therefore, that the drugs do act on the fish as anesthetics and that the rapidity of action on the fish is a measure of the rapidity of the anesthetic action of the drug itself. This is borne out by clinical results and by the work on frogs.

The frogs were prepared and tested by the method described by Rider.[22] The sciatic plexus was used and the onset of sensory anesthesia determined by the failure of the frog to withdraw his leg after direct stimulation of the foot. Table 6 is self explanatory.

On both the fish and the frogs, the alkaline solutions seemed to be much more rapid in action. It was reasoned that a solution which seemed to penetrate the nerve bundle so rapidly might be taken up more thoroughly and that a more nearly complete anesthesia might be expected.

The occasional partial failures, especially in the mandibular injection, have been explained upon the basis that the solution did not penetrate the entire nerve bundle and that therefore the pulps of one or more teeth were not completely anesthetized. If we have an anesthetic

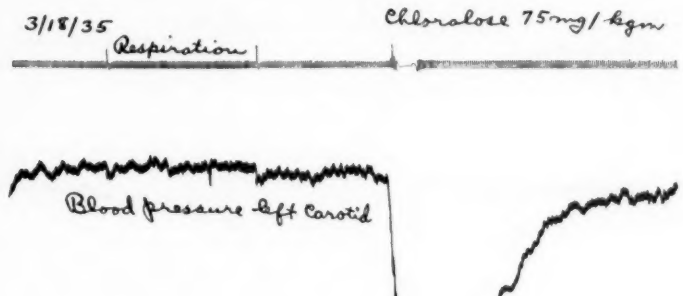


Figure 3.

22. Rider, T. H.: J. Pharmacol. & Exper. Therap., 39:329-341 (July) 1930.

that is taken up rapidly and completely by the nerve bundle, we might expect to overcome this difficulty. We had hopes that trials in the clinic would bear this out, but we were disappointed in this, for while the anesthetic took effect much more rapidly than the ordinary acid solution, our percentage of failures was just about as high, as the table will show.

The injections selected were the infiltration for upper bicuspids and the mandibular and buccal injections for lower molars. The amounts injected were 2.5 c.c. for the upper bicuspids and 3.5 c.c. for the lower molars. In the bicuspid area, the tooth was tested for anesthesia one minute after injection, and every thirty seconds thereafter until anesthesia was complete. Testing was done by prying against the socket and the root. In the mandibular injection, the buccal injection was given as soon as lip signs were noticed and the tooth tested immediately and then every thirty seconds thereafter.

These injections were given in the clinic mostly by students, and there is no doubt that many failures were due to poor technic and not to the solution itself. The instructors in the clinic have had no complaint to make of the solution. We have noticed no toxic effects on patients and have not found that the after-pain has been increased. It might be expected that there would be more after-pain because the solution is hypotonic. Freezing point determinations were made by Mr. Allen with the 2 per cent procaine-epinephrine in Ringer's and in the sodium carbonate solution. It is known that anesthetic solutions having the same freezing points as blood are also isotonic with it. The procaine-epinephrine-sodium carbonate solution had a freezing point of 0.345 C. Blood freezes at 0.55 C.; which makes the above-mentioned solution hypotonic. The procaine-epinephrine-Ringer's solution had a freezing point of 0.685 C.; which makes it hypertonic. The freezing point determinations were made by routine method with a Beckmann thermometer.

A point that has not been brought out is the comparative instability of alkaline procaine-hydrochloric acid-epinephrine or procaine-borate-epinephrine solutions. As the solution approaches the neutral point and passes over to the alkaline side, more and more basic procaine is freed. This is very unstable and deteriorates rapidly. The solutions cannot be boiled without marked impairment. Our method of making the solution in the clinic is as follows: Twenty cubic centimeters of the sodium carbonate solution is boiled. A tube containing 20 sterile tablets of procaine-epinephrine is opened carefully and the contents are immediately emptied into the hot sodium carbonate solution. This solution is used within one half hour.

Procaine base solution which anesthetized gold fish in sixty seconds had no effect on them whatever after being boiled and allowed to stand over night. (Table 4.)

Reasoning that a solution that was very rapidly absorbed might be more toxic than one with a slower absorption rate, we performed the following experiments on albino mice after the method described by Dailey[1] and on cats after the method described by Eggleston and Hatcher.[23] In mice, it will be seen by the chart that the alkaline solution was more toxic than the ordinary acid solution. This was apparently caused by the more rapid absorption of the alkaline solution. In the cat, using rapid intravenous injection of the alkaline and acid solutions had exactly the same effect. This also might be expected because it is generally ac-

23. Eggleston, C., and Hatcher, R. A.: J. Pharmacol. & Exper. Therap., 13:433 (Aug.) 1919.

cepted that the toxicity of procaine depends largely on the amount of the drug present in the blood stream at any one time. Both solutions being injected directly into a vein, there should be no difference in their action, provided the sodium carbonate itself had no toxic action.

### CONCLUSION

The time for onset of anesthesia with alkaline solutions of procaine hydrochloride is much shorter than with ordinary acid solutions. In the extracting clinic, it is noted that anesthesia wears off more rapidly, although there is sufficient time to complete almost all types of operations in the mouth. For operative work, it is quite likely that solutions producing anesthesia of longer duration will prove more satisfactory. The fact that the toxicity of the alkaline solution seemed to be higher on subcutaneous injection in mice is not a serious disadvantage. It is very rare indeed that a toxic subcutaneous dose is necessary in dental operations.

The rapid deterioration of the alkaline solution on boiling or standing, particularly when epinephrine is used, is a serious disadvantage. In ordinary dental practice, it is not easy to keep tablets of procaine sterile after the tube has been opened. For this reason, these solutions should be boiled. It is not possible to boil alkaline solutions without serious deterioration.

## ANOMALY IN DENTITION: REPORT OF A CASE

By O. R. HODGIN, D.D.S., Thomasville, N. C.

C. S., aged 28, and apparently in good physical and mental health, came in in August, 1934, for dental service. A clinical examination revealed the presence of fourteen bicuspids and molars. The anterior teeth, both maxillary and mandibular, had been removed several years previously. The remaining teeth were well formed. Their investing structures were so affected by periodontoclasia that

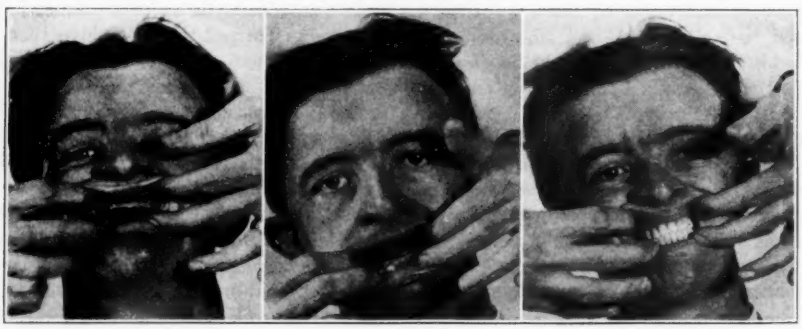

Fig. 1.—Left, view of upper ridge; center, view of lower ridge; right, appearance of inserted plates. No natural teeth can be seen without the use of the roentgen rays. The ridges are normal in every respect.

Fig. 2.—Lower right half of mandible; incisal and occlusal view of ten fully formed impacted teeth: three incisors, one cuspid, five bicuspids and one third molar. (Picture made with a 2¼ by 3 inch occlusal film.)

Fig. 3.—Left half of mandible, showing three impacted incisors, one cuspid and three bicuspids. There is a third molar present, but this picture does not extend far enough back to show it.

extraction of the remaining teeth was indicated. This was carried out without difficulty and there was uneventful healing of the alveolar ridges. In December, 1934, dentures were constructed, with very satisfactory results.

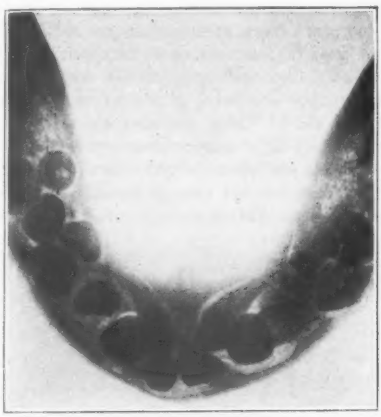

Fig. 4.—Occlusal view taken with patient holding film between arches and rays directed under chin. There are fifteen fully developed impacted teeth.

Fig. 5.—Upper anterior part of arch, showing eight impacted teeth. Two molars are not included in this picture.

In March, 1935, the patient returned with the comment that he had a bad case of the toothache, as if all the previously extracted teeth were back in the jaws and aching at the same time. A clinical examination at this time revealed only a small area of inflammation due to irritation by

the lower denture. The patient returned three days later, at which time a roentgen-ray examination was made of the inflamed region. The findings were so vague that new exposures were made of the entire dental field. These revealed the presence of twenty-eight supernumerary teeth imbedded in the alveolar processes. In May, 1935, two incisors were removed from the mandibular anterior region. Their removal was followed by severe hemorrhage, but the wounds healed promptly and the dentures are still serving very satisfactorily. The patient has been advised to submit to the removal of the remaining unerupted teeth, but to date he has been reluctant to do this.

Fig. 6.—Lateral view of two arches taken on 10 by 12 inch film and reduced.

A physical examination and history reveal some rather interesting facts. Until the age of 9, the patient was very unhealthy, suffering from a chronic diarrhea. The clavicles were not ossified, but gradually began to ossify at about 18 years of age. They are still very small and the patient can bring his shoulders completely together. A roentgen-ray examination reveals the presence of bilateral cervical ribs. A Wassermann test gave negative results. It is reported that at birth the anterior and posterior fontanels were very large, but they gradually filled in completely. A son of the patient, aged 27 months, was born with no bone on the top or back of his head, the attending physician reporting this a "cleidocranial dysostosis." Roentgen-ray examination at this time reveals progressive ossification. As far as can be determined at this time by clinical and roentgen-ray examination, the child's dentition is normal. The dentition of the brothers and sisters of the patient likewise has been normal.

Up to Feb. 11, 1936, the patient had had no more teeth extracted and was wearing his dentures with no discomfort. He was still advised to have his teeth removed at an early date. From the absorption of the ridges, due to the pressure of the dentures, the tips of two or three teeth could be seen.

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# MIXED TUMOR OF THE PALATE: REPORT OF CASE*

By CHARLES R. REIN, M.D., and M. HILLEL FELDMAN, D.D.S., New York City

ALTHOUGH mixed tumors of the parotid and submaxillary glands occur quite frequently, similar tumors of the hard palate are relatively rare. Eggers[1] made a careful survey of the literature and concluded that, until 1928, only eighty-seven cases were on record. Recently, Abshier[2] reported six additional

*From the Skin and Cancer Unit of the New York Post Graduate Hospital and Medical School of Columbia University (George M. MacKee, director), service of Fred Wise.

1. Eggers, H. E.: Mixed Tumors of Palate, Arch. Path., 8:378 (Sept.) 1928.

2. Abshier, E. B.: Mixed Tumors of Palate, Arch. Derm. & Syph., 32:622 (Oct.) 1935.

cases and referred to three others. These nine patients were the only ones with this condition who were seen in the New York Skin and Cancer and the Presbyterian hospitals during the past ten years.

The following case is reported because of the apparent rarity of this condition and because of the unusual history.

REPORT OF CASE

*History.*—J. S., a salesman, aged 29, born in Russia, was first seen at the Skin and Cancer Unit of the New York Post Graduate Hospital April 4, 1935, complaining of a mass of nine months' duration involving the roof of the mouth. The patient had punctured the "roof of his mouth"

Appearance of mass, in roof of mouth.

with a fish bone, early in August, 1934. Immediately after the incident, he noticed a small lump in the region of the puncture site. The tumor increased slowly in size and was incised by a local physician in January, 1935, but no pus was obtained. After the incision, the mass continued to increase in size, but it did not cause any pain or discomfort. The lesion did not ulcerate.

The family history was negative except that the patient's mother had diabetes. The patient had been in good health. The tonsils and adenoids were removed in 1913.

*Physical Examination.*—The physical examination was negative except for the mass in the roof of the mouth, shown in the accompanying illustration. The palate was highly arched and narrow. There was a rounded firm reddish blue lobulated tumor measuring 1 by 1.5 by 2 cm. on the posterior half of the left side of the palate. The mass extended from the alveolar ridge to just beyond the midline and was fixed to the palate and the mucous membrane. There was no involvement of the soft palate. The patient experienced no difficulty in swallowing and there was no local pain or discomfort. A small piece of tissue was removed for microscopic examination.

*Microscopic Examination.*—The section was covered by a moderately acanthotic epidermis, the granular and horny layers of which were wanting and the basal cell margin was intact. At one edge of the section, there were some mucous glands and alongside were groups of large round cells assuming a glandular arrangement. These appeared to be epithelial cells, more of the embryonic basal-cell type. In another region, there was a mass of dense fibrous tissue containing a considerable amount of pigment. Throughout the section were a moderate number of markedly dilated vessels, irregular in shape and some filled with blood elements. There was little or no inflammatory process. It seemed that the tissue might be part of a mixed tumor. The amount of tissue was too scanty to afford a definite diagnosis. Another biopsy or complete excision was suggested (by Wilbert Sachs).

*Result of Tests.*—The Wassermann, Kahn and Kline tests for syphilis were negative. The urine examination was negative.

*Otolaryngologic Consultation.*—The tonsils were absent (removed twenty-two years previously). The pharynx and larynx were negative and frontal sinuses negative. Both antrums were dark to transillumination. A roentgenogram of the floor of the mouth and accessory nasal sinuses was negative except for possible slight thickening at the floor of the right antrum.

*Operation.*—The operation was per-

formed (May 11, 1935) under local procaine anesthesia by Robert H. Kennedy, of the tumor clinic. An oval incision was made surrounding the scar and continued at either end forward and backward from the bone with no definite lines of cleavage, so that the mass came away in pieces. Two sutures were placed posteriorly through the portion of the soft palate which had been opened and the cavity was packed with sterile gauze held in place by one catgut stitch. On removal, the tumor appeared as a firm fibrous mass without a definite capsule.

*Postoperative Findings.*—Examination of tissue removed at operation (D. S. D. Jessup): Section of different areas showed scattered alveoli lined by small cuboidal cells. The alveoli were in a dense fibrous stroma which showed marked vascularity, old hemorrhage and blood pigment. There was some granulation tissue. There were some normal mucous glands. While there was no cartilage present, the type of new growth resembled mostly a mixed tumor. Mitoses were hard to find and the growth was probably relatively benign. Microscopic diagnosis was mixed tumor (hard palate) of the salivary gland.

COMMENT

The patient has been seen at frequent intervals since the operation. The wound has completely healed with good cosmetic results. At this time (November, 1935), there is no evidence of a recurrence.

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# PROGRAM OF THE RESEARCH COMMISSION AT THE NATIONAL BUREAU OF STANDARDS*

By P. C. LOWERY,† D.D.S., F.A.C.D., Detroit, Mich.

MOST of you know that the Research Commission supports a research fellowship at the National Bureau of Standards and that, through this fellowship, the Association and the Federal government conduct a cooperative study of the physical and chemical properties of dental materials.

RESEARCH ASSOCIATE PLAN

As far back as 1892, the Congress of the United States authorized the use of the technical and research facilities of the government under specific conditions by outside scientific investigators and students. Later, in 1901, Congress extended this privilege to include certain specified and technical establishments of the government. The Bureau of Standards was included in this act. Persons outside who are allowed to conduct investigations must be approved by the director of the Bureau and work under his direction. They are technically known as research associates. At the present time, the American Dental Association has three research associates investigating dental materials: George C. Paffenbarger, D.D.S.; W. T. Sweeney, A.B. (physicist), and John R. Beall, B.S. (mechanical engineer). Bureau of Standards personnel who are assigned to this work by the director and who are paid from Federal funds are Wilmer Souder, Ph.D. (physicist), chief

*Read before the Section on Partial Denture Prosthesis at the Seventy-Seventh Annual Session of the American Dental Association, New Orleans, La., Nov. 6, 1936.

†Chairman, Research Commission, American Dental Association.

of the Dental Materials Research Laboratory, and Irl C. Schoonover, Ph.D. (chemist).

Under the research associate plan, the American Dental Association pays the salaries of the research associates and procures the materials that are to be studied. The Bureau of Standards supplies the laboratory space, permits the use of its apparatus and scientific instruments and, what is very important, makes its scientific staff of approximately 500 technical men available for consultation and advice.

The research associates are subject to the same rules and regulations as are the members of the Bureau staff. They are responsible to the Bureau officials and to their own organizations. The Bureau directs the work and publishes the results. Of course, the Research Commission and the Bureau of Standards consult each other and have a program mutually agreed on.

The American Dental Association could no where else find an institution with the facilities and prestige of the Bureau of Standards with which to work.

## GOVERNMENT INTEREST

Certain of you may wonder why the Federal government is interested in cooperating in a study of the physical properties of dental materials. In the first place, the various government dental services, such as the Army Dental Corps, the Navy Dental Corps, and the dental divisions of the Veterans Bureau and the Public Health Service, buy large quantities of dental materials. The purchasing of materials on such a scale is really satisfactory only when adequate standards or specifications are available. As these were not available, the government, via the Bureau of Standards, proceeded to develop them. The Association began to cooperate in this program in 1928, when the American Dental Association research fellowship began to function. The Weinstein Research Laboratories conducted the fellowship during the years 1922-1928. Prior to that time; i. e., from 1919 to 1922, the Bureau of Standards conducted this research alone.

There is another and still more important aspect to this plan from the point of view of the public, and that is that this investigation is not being conducted alone for the benefit of the dental profession. It is of direct benefit to every person in the United States who has to seek the services of a dentist. The dentist is primarily interested in this work and contributes annually to its support because it enables him to render a better health service. I believe that it is of great mutual advantage to have both the organized profession as represented by the American Dental Association and the public as represented by the Bureau of Standards active in such an investigation. One supplements the other, and the combination tends to make the work authoritative in much the same manner as that of the United States Pharmacopeia.

## THE RESEARCH PROGRAM

The primary object of the work is to develop standards for materials already in use. Now to develop a satisfactory standard is no mean undertaking. It is, of course, for this reason that they have not been developed heretofore.

These standards or specifications are formulated by: (1) procuring in the open market standard trade brands of materials; (2) determining those chemical and physical properties which are of importance as far as their dental uses are concerned, and (3) procuring from the profession clinical opinions and observations, as well as actual data on the technic of using the material. With this informa-

tion available as a basis, a tentative specification is formulated.

The word formulate means to state definitely and clearly, and that in a specification is extremely important. All of the tests and details must be so stated that precise verification of all tests can be made. The tentative specifications are submitted to dental schools, government departments and manufacturers for their suggestions and criticisms. They are then presented to the Research Commission and the House of Delegates of the American Dental Association for their consideration and approval. If they are approved, they become the official specifications of the Association.

Eight such standards have been adopted up to the present time. These are for amalgam, inlay casting investment, impression compound, inlay casting wax, inlay casting gold, dental mercury, wrought gold wire, and dental cementing medium (zinc phosphate cements). These specifications are being revised from time to time as additional knowledge becomes available, and as new materials are developed.

I think it should also be pointed out here that the profession is in reality preparing and sponsoring these specifications. In other words, the manufacturer is not telling the dentist what to use, but the dentist is telling the manufacturer the quality that he wants in the materials which he is using. Often the point of view of the dentist and the manufacturer is not the same when a specification is being formulated.

### CERTIFICATION PLAN

After the specifications have been made official, the Research Commission asks the manufacturers to certify that the materials that they make will comply with the American Dental Association specifications. Before any certificate from the manufacturer is accepted by the Research Commission, it must be shown that the manufacturer has adequate equipment and personnel to conduct the necessary tests, or is consulting a laboratory that has the necessary qualifications. A sample of the test data with other details, such as the name of the observer of the tests, the equipment used, the date of the testing and the frequency of the tests, is required. After this portion of the program has been complied with, the Research Commission procures on the open market a representative sample of the material being certified and instructs their research associates at the National Bureau of Standards to test the material in order to ascertain whether it complies with the specification as the manufacturer states. All of those materials, which are thus certified to the Commission and which are found to comply with our tests, are placed on a list of certified products. These lists are published from time to time in THE JOURNAL, and reprints are always available from the office of the secretary of the Research Commission. On the present list, there are forty-seven amalgams, eight investments, seven modeling compounds, six inlay waxes, fifty-one inlay gold alloys, twelve dental mercuries and fourteen wrought wires. The zinc phosphate cements are now in the process of certification. A casual glance at this list will show you that practically every one of the leading manufacturers of dental materials are actively supporting this program. They have gone to the trouble of testing and certifying their materials to the Commission. These manufacturers who are willing to cooperate with us deserve the active support of the profession in purchasing materials.

As a further check from time to time, the Research Commission procures on the open retail market samples of all of the materials on this list of certified products

and has been tested by their research associates at the National Bureau of Standards for compliance with the specification. If at this time any material fails to pass the specification, it is omitted from the list.

The Research Commission believes it has a very sound policy and one that protects the dentist in purchasing materials, and through him the public. They believe that it is a great advance over the system in vogue prior to this work. What was that system? Manufacturers' advertising and sales promotion activities, personal testimonials of men who were often interested in the product financially, secret formulas, magic ingredients and recently discovered panaceas, and the clinical testing of the material by the dentist. Our research associates will advise us promptly when any unique materials are discovered.

In my own field of prosthesis, I, like many of you, have had very bitter and disappointing experiences with denture materials. I have used the so-called "cut and try" method. My patients, like yours, have often been the testing laboratory. Many times in the past, I have wished that there were some standards for these materials whereby I could obtain some information on their relative merits. That time is coming, for the Research Commission is working actively on this problem, and in the Section on Full Denture Prosthesis a progress report of this research on denture materials is being presented. This, the second progress report on denture materials, is in no sense a final report. When sufficient data are available, a standard for these materials will be written. Such a standard can be used to rate the relative merits of the materials. Practically all of these materials are now in the experimental stage, and the Research Commission does not have sufficient information to make definite recommendations at this time.

In addition to the work on denture materials, a study of the silicate cements is also in progress. A report of this work is being presented in the Section on Operative Dentistry, Materia Medica and Therapeutics.

### SERVICE TESTS

I do not wish to belittle actual service or clinical tests of dental materials. They are absolutely necessary and are the final criterion in the judging of any product; but the materials must have prior laboratory testing. Standards must be formulated. Otherwise, we will continue to have the chaotic condition that prevails in the denture material field today. History does repeat itself. Just recall all of the various materials that you have tried clinically and found wanting, all of the gadgets that you purchased and that now collect dust on your laboratory shelves, and all of the expense and disappointment ensuing to yourself and to your patients. The dentist does not want to continue such a system. We know he does not, because he supports the work at the Bureau of Standards in no uncertain manner. In fact, the denture base situation became so confused that the American Full Denture Society passed a resolution, which, in a very similar form, was presented to the House of Delegates, and was passed by it. This resolution requested the Research Commission and the Bureau of Standards to commence a study of the denture base materials as soon as practicable. The National Society of Denture Prosthetists at this meeting allocated $500 to the Research Commission to be used in the study of denture bases.

### EDUCATIONAL PHASE

The Research Commission is interested not only in the scientific phases of the investigation at the Bureau, I mean the theoretical, ideal and speculative phases,

but also in the practical application of the work. In a different way, I could say that we want the laboratory work transferred in as large a measure as possible to the dentist's own laboratory. In order to acquaint the profession directly and intimately with the work, the Commission has appointed a cooperating committee of dentists to conduct experiments on materials under the direction of the fellowship at the Bureau. These experiments are necessarily elementary ones, because the dentist does not have any elaborate equipment, nor is he trained to conduct involved experiments. Nevertheless, the experiments that the cooperating committee performed do show the findings of our investigators at the Bureau in such a manner that the dentist is able to apply the principles in his routine procedures. In turn, the cooperating committee of dentists acquaint their brother practitioners with their findings, and thus the work becomes widely disseminated. Then, too, our workers at the Bureau derive valuable information and experience from the cooperators' findings.

Recently, the Curriculum Survey Committee of the American Association of Dental Schools made a strong recommendation that a course be instituted in all dental schools which would be in a large measure a study of the materials that the dentist employs and of the best methods of using them. Such a course has been in use in many schools for several years, but the vast majority of the schools still do not have adequate instruction in this field. The Research Commission hopes that only duly qualified and adequately trained men will be selected to conduct such courses of instruction.

It is a fact that the only way a dentist can repair the ravages of dental decay is to replace the lost part or parts by inert materials. A large percentage of the dentist's time is occupied in the use of these materials. It is certainly reasonable to state that the student of dentistry should have an intimate knowledge of how to use them to the best advantage. We all know that they are none too satisfactory. Therefore, it behooves us to use the highest grade of materials and in a manner that will assure their maximum efficiency in service.

# IMPACTED AND MALPOSED TEETH*

By J. P. WAHL, D.D.S., New Orleans, La.

SINCE the inception of modern oral surgery, impacted and malposed teeth have received exhaustive consideration from the dental surgeon.

The human race must have suffered, at all times, the same ill-effects from these abnormal conditions as the present generation, as roentgenograms taken of the Egyptian mummies, dating back over 3,500 years, revealed that these people were the possessors of impacted and malposed teeth.

In the volumes of dental literature that have been published, numerous articles have appeared discussing the causes of this condition, but in none of these has a cause been given that will apply in all cases. For instance, in some of these articles, the

*Read before the Section on Oral Surgery, Exodontia and Anesthesia at the Seventy-Seventh Annual Session of the American Dental Association, New Orleans, La., Nov. 6, 1935.

authors attribute this condition to the arrest of the vertical or height growth and lack of the longitudinal growth of the jaws, while others assert that they may be due to heredity or lack of function of certain of the ductless glands. A few others assert they are due to a displacement of the tooth bud.

In more than 1,000 cases that came under my supervision, the mandibular third molars were found to be most frequently impacted and malposed, while the maxillary third molars came next and then the maxillary cuspids. As these teeth are the last to erupt and take their places in the normal dental arch, is it not plausible that a lack in the longitudinal growth of the jaws is one of the most likely causes for impaction and malposition? I say one of the most likely causes, because, while inadequate growth of the jaws may account for impactions, I have seen a great many cases of impaction and malposition with more than sufficient space in the dental arch.

There are other conditions also that might contribute to impaction and malposition, such as a previous malposition of other teeth and acute infectious fevers in childhood, such as scarlet fever and measles, which may often cause a deposit of dense bone in the path of the erupting tooth, the crown of the tooth becoming deflected and the tooth impacted or malposed.

Extensive inflammatory conditions of the jaws, in early life, brought about by caries or other conditions; traumatic injury from falls or automobile accidents; contraction of the arch produced by excessive mouth breathing due to nasal obstruction, and thumb sucking may also cause any of the teeth to become impacted and malposed.

Too early extraction of the deciduous teeth may cause a malposition of the permanent tooth bud and thereby cause the tooth to become impacted and malposed.

Orthodontic treatment, if carelessly employed, will cause teeth to become impacted and malposed. On the other hand, a great many of the cases, especially the third molar impactions that require surgical treatment, are referred by the orthodontist because he realizes that he cannot maintain the normal relationship of the other teeth as long as the third molars, because of their abnormal positions, are causing an undue pressure on the second molars, which causes the other teeth to be pushed out of alinement.

Impacted and malposed teeth may be either entirely embedded in the substance of the bone or only partially so. All impacted teeth are malposed, but not all malposed teeth are impacted. A malposed tooth is a tooth that is not in its normal position in the dental arch, while an impacted tooth is a malposed tooth that is in abnormal contact with another tooth. It is my opinion that all impacted and malposed teeth, with a few exceptions, should either be placed in their normal position or be removed.

An early diagnosis is essential if we wish to preserve the health and comfort of our patients.

Roentgenograms should be made of all areas where teeth should have but have not erupted. I would like to emphasize the importance of making roentgenograms, especially of the third molar regions, for all patients 15 or 16 years of age who come in for dental treatment. I believe a great humanitarian act would be accomplished if such a procedure could be forced on every practicing dentist in our land. It is usually at the above-mentioned age that the third molars are erupting or should be, and a good roentgenogram will reveal whether the tooth or teeth will erupt normally or become impacted. Our advice, if given at this time, is invaluable to the patient.

If the roentgenogram reveals a third molar that we think will eventually become impacted or malposed and if the root ends of the second molar are fully formed, we should advise that patient to have the tooth removed at once. The younger the patient, the easier the operation will be for the patient as well as for the operator. The bone of a young person is much easier to remove; therefore, less trauma is produced, and as young people have a far greater resistance than older people, recovery is much more rapid and less complicated. Again, a young patient is not apt to have already become affected with the cardinal or psychopathic symptoms that are usually found in older patients who have impacted or malposed teeth.

During our college studies, we learned that after the crown of a calcifying tooth had been completed, the enamel organ finished its physiologic functional activity and, in those that erupt, the remnant of this functionless enamel organ is precipitated on the surface of the crown of the erupted tooth; and through use of the tooth, this membrane is destroyed; but, in completely embedded, malposed and impacted teeth that are fully formed, the remnant of the enamel organ (Nasmyth's membrane), not being exposed to mechanical forces, is not destroyed and, after a certain length of time, loses its function and acts as an irritant to the surrounding tissues. This inflamed tissue is, of course, low in resistance and is very susceptible to bacterial invasion, from such foci as teeth, tonsils and sinuses, either through the blood stream or through an opening from the site of the impaction to the oral cavity. For the past year or so, whenever possible, in cases of arthritis, I have made it routine practice before operating to determine whether there was any communication between the completely impacted or malposed tooth and the oral cavity. In 75 per cent of the cases examined, I found an opening.

The method I used to determine the opening was as follows: After obtaining anesthesia of the parts, an incision was made through the mucoperiosteum, which was then elevated, the bone being exposed, and a sharp-pointed instrument of the proper size and shape passed along the distal surface of the second molar and, with very little pressure, allowed to pass from the surface of the bone to the impacted or malposed tooth. In quite a few cases, this opening was found to be very large; while in others, it was very small. In several cases, the opening was found in other spots over the surface of the bone covering the embedded tooth.

It is true that impacted or malposed teeth may be present in the jaws for years without the slightest appreciable local or systemic symptoms, but the great majority of these teeth do cause trouble, especially the mandibular third molars. Again, why should we permit our patients to take a chance with these teeth when we know that sooner or later they will give trouble, and at a time when the patient will be much older, with less resistance and a more dense bone?

These conditions, plus the systemic complications, only make recovery more uncertain. I would not hesitate to remove four impacted third molars, for a young person, under a general anesthetic, while I would not attempt to remove more than one impacted tooth for an older patient.

The partial impaction or eruption of mandibular third molars causes more physical disturbance than that of any of the other teeth, owing to the anatomic arrangement of the tissues in this region.

Inflammation of the tissues about a partially impacted mandibular third molar often extends to the surrounding muscles and glands, which become in-

volved, a temporary ankylosis resulting, in some cases of a sufficient degree to cause complete fixation of the mandible. In a great many of these cases, the infection is of a virulent type and the patient dies.

In the presence of malposed or impacted teeth, as the patient becomes older, he may be affected with reflex pains, epilepsy, chorea, facial spasms, dementia precox, mania, paralysis, sensory alterations, neuralgia, paroxysmal pains, insomnia, muscular twitching, melancholia, neuritis, arthritis and loss of memory. Some cases of loss of vision have been reported.

Quickly forming cysts of the jaws are often found to contain a malposed tooth either fully or partially formed.

Various technics have been devised for the removal of malposed or impacted teeth. Some of these are very good. The operator should select the technic that will answer best in his hands, and one that will permit him to take his time to dissect the tooth out with the minimum amount of trauma to the parts.

Before attempting the removal of a malposed or impacted tooth, the operator should be thoroughly familiar with the anatomy of the surrounding parts and he should have made a complete and thorough diagnosis from a good roentgenogram. One should never operate in the presence of an acute inflammatory condition. The acute condition should be reduced first; as, otherwise, serious consequences might develop.

The bleeding and coagulating time of the blood should always be determined before operating. This is essential as patients with a coagulation time of over four and one half minutes and a bleeding time of over four and one half minutes constitute unsafe risks and should be treated until the bleeding and coagulating time has been reduced to normal.

I prefer to use a general anesthetic and to operate in the hospital under strictly aseptic conditions, although the selection of the anesthetic should be governed entirely by the physical condition of the patient and the condition of the surrounding tissues in the field of operation.

After removing a completely embedded malposed or impacted tooth, one should be very careful to remove also the remnant of Nasmyth's membrane in its entirety. If this is not done, this membrane may be the center of irritation from which a cystic formation may have its origin.

### REPORT OF CASES

Case 1.—Mr. K., aged 47, had had a severe attack of neuritis about three years previously, and, on consulting his physician, was advised to have his tonsils removed, which he did. After three months, the neuritis disappeared. Later, it returned, and the patient was advised to have the appendix removed, which he did. Shortly, a kidney stone was removed, the neuritis again disappearing, with recurrence four months before this report was made. The physician then referred the patient for an oral examination. A roentgenographic examination revealed a badly impacted mandibular left third molar. Within a few days after its removal, the neuritis ceased, and no pain has been experienced since.

Case 2.—Miss D., aged 20, had influenza in 1932, with much pain in the left leg and the back. In 1933, she began to suffer from a pain in the head starting in the region of the upper left lateral incisor and bicuspids and passing all through the face. Extraction of the left lateral incisor and first bicuspid did not relieve the pain, but rather seemed to aggravate it. The pain increased until it became unbearable. There was swelling of the face and the patient's memory became affected. Just before a lapse of memory, there would be a severe pain in the back of the head. A roentgenogram revealed a badly malposed maxillary left cus-

pid, which was removed under a general anesthetic in April, 1934. The patient has been entirely free from pain and lapse of memory since that time.

CASE 3.—Mrs. W., aged 22, had had an automobile accident of no consequence at the age of 15, and several months later had had to be taken out of school because of a nervous breakdown. A two months' stay in a sanatorium apparently resulted in a complete recovery. The patient attended college for two sessions and then was married. Two years later, in 1934, she had a much more severe nervous breakdown. A five-weeks' stay in the same sanatorium resulted in recovery, but another attack occurred in December of the same year. During the attack, the patient refused nourishment and would not answer questions. She had a very simple expression and hated the sight of her mother. A roentgenogram revealed four impacted third molars, which were removed in the hospital Jan. 8, 1935, at one operation, under a general anesthetic. There have been no further attacks and the patient is happy and normal.

CASE 4.—Mrs. F., aged 28, complained of a fullness in the front part of the face near the base of the nose, severe pains in the back of the head, darting pains beneath the eyes and constant dizziness. Her face was covered with pimples. The dentist devitalized the central incisors, but this did not afford relief. The patient was then advised to have the left maxillary lateral incisor removed; but this gave no relief. As a last resort, she had the maxillary left bicuspids devitalized; but still there was no relief. She was extremely nervous. Roentgenograms revealed two impacted maxillary cuspids, which were removed. On her next visit, the patient reported that the pain had left her and that she could not remember when she had felt better.

CASE 5.—Mrs. G., aged 49, had a very badly scarred face and a suppurating sinus under the mandible on the right side. She stated that as long as she could remember, she had had pains in the right side of the face in the region of the mandible. Four years previously, she developed a swelling of the face, which was poulticed and opened externally. The opening had never closed and had always drained pus. The patient was referred by her dentist to a general surgeon, who recommended an operation for necrosis. The operation did not relieve the condition. After three months, she consulted a surgeon in Baltimore, who, on roentgenographic examination, advised another operation. This operation did not relieve the condition, and the patient left for home very much discouraged. She was finally referred to this office by a physician. A roentgenographic examination revealed an inverted malposed mandibular bicuspid. On removal of this tooth, the condition cleared up in a short time. An examination of the tooth after removal revealed that the apical end of the root and also a portion of the crown had been removed in the previous operation.

# THE PROBLEM OF INCREASED VERTICAL DIMENSION IN PARTIAL DENTURE CONSTRUCTION*

By FRED H. HALL, D.D.S., Nashville, Tenn.

IN discussing the subject of increased vertical dimension in partial denture construction, I am, I realize, in a highly controversial field, and there probably will be marked differences in opinions concerning statements made in this paper, which are based on experiences in my own work in private practice and are therefore not so full as I would have them. If others can be stimulated to give their observations, we shall have a more comprehensive understanding of this problem. Let us keep an open mind that we may correct any false deductions reached collectively, deductions being as yet limited in this great field, because everyone's testimony is not yet of record.

"Every piece, exclusive of full denture, that depends on the soft tissue in part or in whole to support it in function might be termed a partial denture."[1] I give this definition realizing that the term "partial denture" has never been standardized. For convenience in discussing this problem, this definition will meet all the requirements. It must be realized also that this includes every type of attachment that is used for retention of these dentures in position.

Why should the problem of increased vertical dimension enter into and complicate the already difficult problem of partial denture construction? Many practitioners have said that partial dentures are never successful when the vertical dimension is increased, since they are limited in their usefulness even in restoring cases in the position found. Many wish to use the term "normal position" for the position in which the case presented itself to them, but we must realize the changes that take place in these mouths from long wear and the loss of teeth. It is true that there are present remaining teeth, but these teeth are often worn off and have been moved from their normal position by the forces of occlusion. Seldom do cases fail to present these changes in varying degrees. It is more difficult to make partial restorations that leave them in their present abnormal position than to restore them to a position that will approach the normal for the particular individual. It will be noted that I am first giving a mechanical reason for my position, but I do not think it is the most important by any means or that it should be given first consideration. Yet I realize that the profession has placed the mechanics of partial dentures above everything else, and before you take issue with me, please recall the great number of mechanical panaceas suggested and heralded as an end to all the problems of partial denture construction that have come or might come into your practice. Often the best that could be said

*Read before the Section on Partial Denture Prosthesis at the Seventy-Seventh Annual Session of the American Dental Association, New Orleans, La., Nov. 7, 1935.

1. Kennedy, Edward: Partial Denture Construction, Brooklyn: Dental Items of Interest Publishing Co., 1928.

of these is that they are beautiful pieces of jewelry; but the trouble is that they are not to be worn where their beauty will be evident. Before the construction of partial dentures can be successful, the problem of mechanics must be placed in its proper position.

The objective that should be uppermost in the mind in increasing the vertical dimension with a partial restoration is the health of the patient. Tissues are not properly nourished if their nourishment is at the expense of other tissues, and the health of the patient will soon be impaired if this is permitted. A crippled and inefficient denture cannot properly prepare food for the organs of digestion, and when the stomach is fed by such dentures, it is overloaded, and

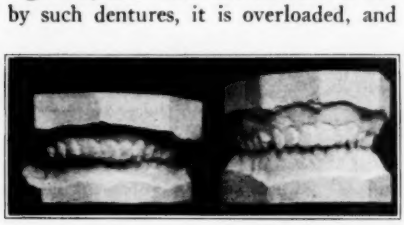

Fig. 1.—Anterior view of case before and after increase of vertical dimension.

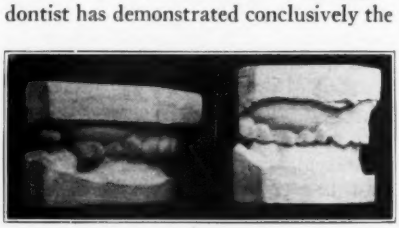

Fig. 2.—Right side of case shown in Figure 1.

disturbances will soon occur. The question might be asked, "Would restoration in the position acquired correct this fault?" My contention is that it will not correct it to any degree comparable to the proper restoration of the vertical dimension and balancing of the case. This statement is made after observing cases in actual practice, not only my own but also those of other men, in various parts of the country. This should be the first consideration since on the feeding of the tissues of the body depends the health of the tissue involved. This should be reason enough for us not to turn our backs on the problem incident to increased vertical dimension in partial work, saying that the hazard is too great and our reputation might be injured by failure. It is said that there are surgeons who will take only the safe, sure cases, refusing to take chances to save lives for fear of increasing their mortality rate. That type of man is a coward and has no place in the professional world.

Not only is the mouth affected by the loss of vertical dimension, but other parts of the body are affected in the same degree, such as the sinuses of the head and the organs of hearing and seeing. Let it be understood that the restoration of lost height in the teeth will not cure all ills incident to these parts, but does create conditions that are conducive to health and its maintenance. The orthodontist has demonstrated conclusively the effect of changing the positions and relations of the teeth to one another in contributing to the health of sinuses, eyes and approximating tissues. The hearing is affected by loss of vertical dimension by the pressure of the condyle heads, since, in closing the mouth, they are carried posteriorly, causing pressure on the auditory canals. Nature, in giving protection to the tissues in this canal, begins to build bone within the canal, reducing the efficiency of the organs of hearing. This has been demonstrated in those persons who became deaf by going edentulous for long periods. In numbers of cases, increasing the vertical dimension has improved, and we believe perma-

nently, the hearing according to both bone and air conduction tests. Figure 1 shows such a case, with models and records of tests made.

I have found also that the mental attitude of the patient is noticeably improved in the restoration of the height of the teeth, but there are no scientific studies available on which any facts as to this phase of improvement could be based. The only testimony I have is that of my patients as they list to me the advantages most noticeable to them. It is to be remembered that testimony from one who has just had a restoration made must not be regarded with so much force as that of one who has had years in which to experience the effects of such changes,

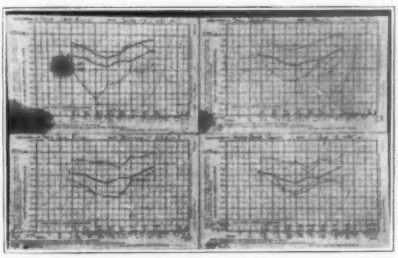

Fig. 3.—Charts made by scientific means showing improvement in hearing after increase of vertical dimension.

as illustrated in Figure 1. From the experience and testimony of many patients that have had the vertical dimension increased for a number of years, I believe that it is beneficial as regards the mental reactions.

Often, malocclusion that cannot possibly be corrected by orthodontic procedure can be corrected by increasing the vertical dimension in the manner illustrated in Figures 4-9. In the case illustrated, the patient underwent many different, but unsuccessful, treatments, and, at the age of 53 years, I increased the vertical dimension in her mouth to allow the mandible to swing posteriorly, bringing the anterior teeth into an approximate end-to-end relationship. In addition to the upper partial denture, jacket crowns were used on the upper anterior teeth to produce the relationship shown in Figure 9. This picture was taken seven years after completion of this work.

It is my conviction that the foregoing is reason enough for us to face the problem of increasing the vertical dimension in the field of partial dentures. The difficulty of the case should only stimulate us to greater efforts. These dental cripples need our help as much as do any others. Should we allow all these patients to become edentulous because we believe that we cannot construct partial

Fig. 4.—Occlusal view of case requiring partial denture and increase in vertical dimension.

dentures that will give service? The public is beginning to doubt our ability to make these dentures in a way that will assure lasting efficiency. This, no doubt, is due, to a very large extent, to the patient's conversation with his dentist, which has discouraged him regarding partial dentures. There are men in our profession who will take study models and never study them, but will show them to the patient and, with a solemn face, advise extraction of all the remaining teeth, in order to make a full denture, and only because it is easier for them to construct a full denture than to make an efficient partial denture. Numbers of these cases

have come to the attention and it makes one realize more and more that many refuse to study and prepare themselves to render service in partial denture work, taking the course of least resistance. If the patient insists on a partial denture, such a dentist has only a stock diagnosis of partial work, which results in a failure, satisfying his mind that partial dentures are of no service. Such a happening is a tragedy. It shows to the world that our profession is not taking hold of its problems and solving them in a scientific manner; and that we are satisfied to let the cause of failures go undetermined. My hope for the future is that more of us will keep records and check results carefully in order that our knowledge may soon become more comprehensive and that we may obtain many basic facts for future teaching and work. No one man's success or failure should establish or condemn a practice.

Fig. 5.—Anterior view of case before and after treatment. The position of the anterior teeth is to be noted.

When we are convinced that a mouth should be restored to its normal vertical position, we should first consider the type of restoration to be made. I am not suggesting a new material or any one type of restoration that will be satisfactory in every case. We have been all too gullible in accepting some man's pet idea as a panacea for all partial denture ills. All of the various methods or types of restorations have good features and serve excellently in certain cases; but the failures have always been more marked than the successes. No physician of any ability has a stock prescription for all ailments. Even in tuberculosis, no two cases are treated exactly in the same manner. One patient may be cured by a few months in bed, on a diet of milk and eggs; while collapse of the lung may be required in another; and to those not trained, the cases look very much the same. The physician does not limit himself with stock treatments or pet hobbies; therefore, he has made progress in the cure of many diseases that were once considered hopeless. Shall our profession continue to limit our own success in the field of partial dentures by the use of stock diagnosis or shall we lay aside the hindrances and really render a service to these dental cripples that come under our care from day to day? To limit ourselves to one type of fixture is as absurd as limiting ourselves to one type of filling material for every type of cavity. In restoring individual teeth with fillings, we vary the material to meet the requirements of the different cavities in question. Just so should we treat partial denture cases and thus bring our success in this field up to the level of our success in the operative field. This will be accomplished only when every dentist takes time to study each individual case of partial dentures and the problems peculiar to it, thus individualizing all cases and never

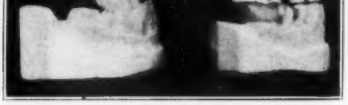

Fig. 6.—Right side of case shown in Figure 5. There is an increase in the vertical dimension and the new position is established by action of the mandible.

generalizing. It is so easy to have a "stock diagnosis" ready for every case; such as taking an impression and sending it to the commercial laboratory. This type of treatment of our partial denture problems only increases the percentage of failures. The first thing to consider in treatment is the age and general health of the patient. This does not mean a general physical examination; yet if the patient is not in good health, it is always best to consult his physician before outlining the course of procedure. Sometimes, our dentures are failures before they are inserted because the general health of the patient is so poor that the tissues of the mouth are not properly nourished; and, oftentimes, such a mouth, when examined at a glance, would lead one to think that the health of the patient was good. Thus, a knowledge of the general health of the patient will cause us to modify the diagnosis in order to render a better service. Many times, we have labored to do something for a patient, only to see failure in the end, because the tissues were not sufficiently nourished to maintain health in the face of the added tax of a partial denture. Therefore, to plan wisely, we must first have in mind the health of the patient, when we can do our part to improve and maintain that health.

Our next consideration should be the teeth, the ridges and all the tissues of the mouth. A full-mouth roentgenogram must always be made in order to determine the condition of the underlying tissues. I know of no other means of determining this condition, a knowledge of which is so vital to the success of our work.

In order to design a bridge properly, even after he has gone over all the surface of the ground involved, the engineer must spend many hours studying a relief map. This routine is always followed, no matter how many similar structures he has designed and built. How many of us make a relief map in the form of models, before diagnosing a case for partial dentures? These models are absolutely necessary to an intelligent designing of the case, and should be oriented on some instrument that we may better see the relationship of the opposing teeth. Thus, the greatest amount of necessary information is gained. I am not naming any special instrument, because one person may use one type to advantage, while another may require an entirely different type. It is my opinion that no instrument can copy accurately every movement of every mandible; hence, the final instrument must be the mouth and not a mechanical instrument. Yet these instruments often help greatly in visualizing the case in hand. The operator should never design a case without a set of good models to help him picture the things required to meet the needs of the particular case in hand. Such models are

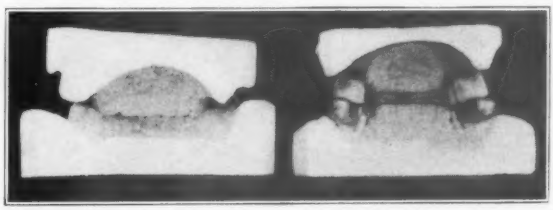

Fig. 7.—Lingual relationship of teeth.

indispensable in designing a fixture that is to be used in increasing the vertical dimension.

In diagnosing a case, there must always be uppermost in our minds the general physical characteristics of the mouth. Cases built without this careful consideration can be nothing but failures. The functions of the dental organs have already been modified by disease when we are called on to construct a partial denture, and therefore differ from the functions of the normal denture. This fact has a vital bearing on the construction of the case. A proper consideration of the modification of function that occurs in the presence of dentures will cause us to modify the size and shape of teeth to be replaced. Too often, we try, with partial dentures, to restore the teeth in their original relationship as to size and form, only to meet with failure because the problems are not in any way the same. True, when fillings are placed in teeth, they are carved and made to conform to the tooth; but here we are not dealing with a crippled organ, but with a diseased tooth; and when the disease is eliminated, normal function is restored. In partial denture cases, normal function can never be restored because part of the organ has been lost, and therefore the restorations should be planned to assure the greatest efficiency for the longest period of time. The question of efficiency and time must be considered in the beginning and the patient must see the true picture of the problem. No excuses should be made for our failures, for thus our loss becomes far greater. If we continue such a practice, the problem of partial dentures will continue to go unsolved, because we are acting in no sense of the word as scientists. Therefore, a careful diagnosis of the case should be made, with all tissues involved in mind, and this will lead to the correct type of restoration. Each case must be individualized.

The abutment teeth to which these fixtures are to be attached are of paramount concern, for on these depend the life of the denture. Because of this fact, we must have uppermost in mind the physiologic function of the individual tooth and also of the entire denture. The individual teeth move in function, and this movement, within certain limits, is absolutely necessary to the health of the tooth itself and to the surrounding tissues. This has been a moot subject, but most men have come to recognize this fact. The thing that has brought it so forcibly to my own attention has been my failures in extensive fixed bridgework. Teeth rigidly fixed by large bridges soon lose the pulp through strangulation, owing to overload and rigidity; but if the bridges allow some movement, these teeth continue to give service without becoming devitalized. The failures in the past in partial dentures can, in a great

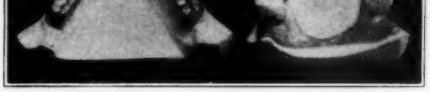

Fig. 8.—Partial denture with precision attachments and so-called bar-clasp working against jacket crowns.

measure, be traced to a disregard of this physiologic fact. This pitfall has been a natural one, and one from which it is hard to escape, since it is the patients' desire to have a denture that will be as steady and secure in feeling as their own teeth and our desire to give them such. Yet a patient can be shown in a short time the functions of the teeth and tissues of the mouth and will gladly cooperate to make the case a success.

So often, in the past, we have accepted the remaining natural teeth as we found them without modifying them to enhance the service of the denture. Since we are considering only cases requiring an increase in vertical dimension, we must modify the remaining natural teeth, if these cases are to have harmony in function. Some teeth may require grinding

Fig. 9.—Appearance of teeth of patient, aged 60, seven years after completion of denture, which remains comfortable.

of occlusal surfaces, while others demand building to occlusion. In this building process, we are able to modify the shape and position of the teeth in order that proper distribution of the forces be received in mastication. The reduction of the buccolingual dimension and the modification of the grooves of the teeth enable us to control, to a large extent, the service of the individual tooth. A set of teeth with properly interlocking cusps are the most beautiful when they are Nature's own handiwork; but to allow our designs to copy Nature's to this extent is disregarding every sign of Nature to the contrary. Within certain limits, these interlocking cusps are essential to the development and health of the natural denture, but, with age, we find Nature modifying these forms in order to maintain health. In cases wherein Nature does not modify these forms, the teeth are lost early from periodontoclasia. This signpost, so prominently displayed on our road, should lead us into the right path and bring us to realize the necessity of modifying cusp form and also the size of the teeth. The function modified by disease or loss of teeth is never the same as the function of the normal growing, developing denture. Our primary thought, the restoration of lost teeth with artificial substitutes belying their iden-

Fig. 10.—Three-tooth fixed bridge (right side of mouth) and single tooth (left).

tity, must be changed to the engineering of a reconstruction that will include every physiologic phase of the case in hand. In increasing the vertical dimension, these facts must ever be before us, as we study and diagnose our case, and to lose sight of one means that our case is not up to standard even before it is made.

The modified function of the ridges must also receive a most careful study, if the denture is to remain for any time in function. In the past, we have depended on the abutment teeth to maintain these partial dentures in function, but this has

failed. The ridges must take the stress of mastication, and not the abutment teeth, if partial dentures are to give the service that should be expected of them. The function of abutment teeth should be to take only the stress originally intended and to retain the denture in position. It can be readily seen that keeping these dentures in position added enough work and any more will mean shorter life for these teeth. It is imperative, therefore, that these fixtures be constructed so that the mucosa receives the working stress. The construction of such a fixture would be easy if all tissues involved were of the same type. Being of different structure, any denture must allow the proper function of all tissues. Because there is more movement of the mucosa than of the teeth, some means must be devised in constructing the fixture to allow the proper stress on the mucosa. There are many different mechanical methods by which we are able to accomplish this. I would not say that the ideal has been found, but with the different designs that we have at our command, we should be able to select the type best suited to each individual case. Cases planned and constructed with these facts before us will continue for a long period to be of service. Those cases that do not allow the stress to be transmitted to the mucosa will fail. Dentures that are used in increasing the vertical dimension, above all, require this transmission of stress to the proper area. The health of the ridges depends on this stimulation, within certain limits. The amount is controlled by designing the fixture as to the area covered, and the amount and direction of the force to be applied. Overstimulation of these ridges is as detrimental as understimulation. The amount of stress that can be withstood by any given ridge depends on the type and density of the underlying bony structure and also the nourishment of these structures; and we must have before us these facts before outlining the saddle area and the type and size of teeth to go on such a saddle. Of course, this will include esthetic considerations, but does not place them before the biologic; a practice which I believe has contributed to our failures.

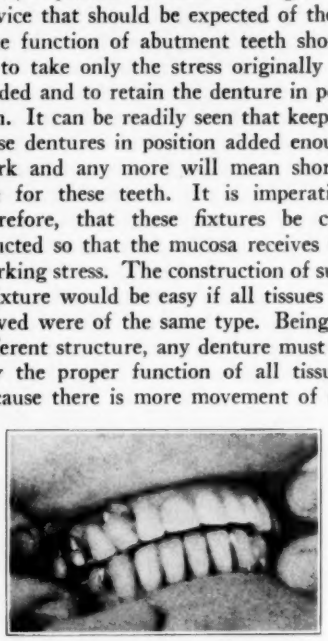

Fig. 11.—Anterior view with denture in position.

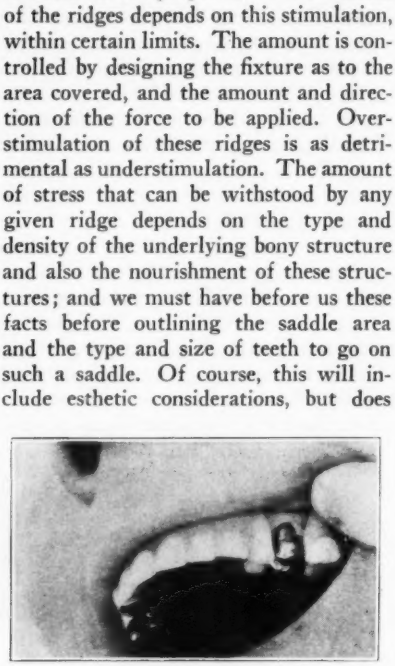

Fig. 12.—Left view, showing clasp on bicuspid.

Following this outline of diagnosis and building has enabled me to construct partial dentures that are serving my patients and, after years of use, are still in functional occlusion with abutment teeth that are stronger and in an improved state of health. In the cases wherein I have failed, the cause can be traced directly to a violation of one of the principles outlined. Chayes has defined an ideal partial denture as one "which will permit the remaining teeth to express themselves to the correct degree so as to main-

tain form, function and nutrition, and will simulate the natural teeth which it is replacing in the exercise of the trinity mentioned."

It is well to consider certain types of retention that are at our command with the idea of recognizing their values and also their shortcomings. The clasp that is the most popular means of retention in use today is, ergo, the most abused, having brought a storm of criticism from a number of men in our profession who maintain that the clasp has no place in modern partial denture construction. If our use of the clasp form of retention is to continue indiscriminately as in the past, I believe the criticism justifiable.

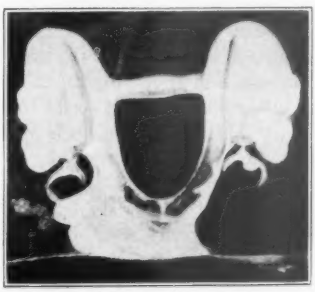

Fig. 13.—Stress-breakers on clasps.

To allow beautifully colored pictures appearing in the advertisements of our so-called certified technicians to influence us in our diagnosis constitutes a crime against humanity. Yet, so often, this has been, and is still, the method used in diagnosing and treating partial denture cases. I am not here to blame or censure the technician, since the blame must be placed wholly upon the shoulders of the profession. It becomes the duty of those who see this evil to condemn it in no uncertain terms in order to check its ravages. Technicians are even called on to diagnose our cases from the models upon which they are to construct the denture in question. Some excuse can be given to the dentist, since the blame must be placed on those leaders who have but one solution of this problem of anchorage of partial dentures. Let us consider what these men have to offer but not be blinded by their excellent salesmanship and fail to see the shortcomings of the dentures in question.

The many different types of clasps all have a place in partial denture work, but study and experience alone will lead to their correct use. The continuous clasp is most often indicated in lower cases with all posterior teeth missing, yet there can be many conditions calling for a modification of this type of restoration. The adapted wire clasp has a very limited use, in my opinion, for the reason that it acts most often as an orthodontic finger spring to move abutment teeth. I see more abuses due to this type of retention than to any other. The bar clasp is a distinct advancement over the old orthodox buccolingual and labiolingual clasps, yet to fail to recognize its limitations is to plunge immediately into another series of failures, bringing the field of partial dentures into further disrepute. The bar clasp can be used to best advantage on small bell-shaped posterior teeth, but must be constructed in such a manner as to allow the abutment teeth normal expression. The old orthodox cast clasp should not be entirely forgotten since, in a limited field, it serves better than any other. One of the best aids in determining the type of clasp to use in a given case is the so-called clasp surveyor, yet this instrument will never serve to diagnose a case.

The type of retention that serves me best in the greatest number of cases is the precision attachment. My failures in the use of these attachments have been due to an entirely too enthusiatic interpretation

of their indications. If properly engineered and constructed, this type of attachment allows the case in hand to serve without undue strain on the abutment teeth and, too, remain in functional occlusion. The one indictment brought against this type of attachment is the mutilation of the abutment teeth. In the hands of certain operators, this was due to a desire to construct a perfect mechanical clasp, with their eyes closed to the living tissues involved. It is my belief that this type of attachment causes less mutilation than any other, since clasps have a tendency to etch the enamel, thereby causing damage to abutment teeth. We must never lay all the blame on patients for not keeping these clasps clean since this is not the reason the teeth are etched. Not one of the critics of precisions attachments will deny that there are many distinct advantages obtained in their use in partial dentures. In increasing the vertical dimension, they enable us to make corrections to a degree impossible with clasps. As already stated, these cases require the restoration of the remaining teeth with fillings and crowns in order to assure occlusal harmony, thereby making a place in most cases for our attachments. The endeavor to make this correction, with lugs of gold and clasps, brings into existence only a piece of jewelry that cannot aid in occlusal harmony, nor is it good looking. The person who has worn both types gives testimony that we cannot disregard when he says that precision attachments give more of a feeling of real teeth than does a lacy piece of jewelry. Added to this is the testimony of the tissues involved, which react better and for longer periods of time in certain cases than with any other type of anchorage. I do not believe that it is more difficult to construct a denture for increased vertical dimension with precision attachments, since it allows the individual expression required by the case in question. If the operator makes his own attachments with band clasp gold, he has further opportunity for individual expression as to the size of attachments, thereby reducing any so-called mutilation. Allow me to repeat that in most cases of increased vertical dimension requiring partial dentures, the precision attachment permits the freest expression in construction.

Cases demanding increased vertical dimension often require the use of a stress-breaker. I make this statement realizing that many men are opposed to this type of construction and are severe in their criticism of it. One criticism is that it causes the loss of the abutment teeth owing to overstress. The function of a stress-breaker is to remove overstress on the abutment teeth and to transfer it to the mucosa, and if it fails to do this, it is not a stress-breaker. It seems that the foregoing criticism is in no way justified because the fixture that does not relieve the abutment teeth when in function cannot come under the classification of a stress-breaker, regardless of the name that we give it. In observing certain so-called stress-breakers, I can see the reason for this criticism, because they do not relieve the abutment teeth of the strain, but, instead, increase it, an earlier loss of these teeth resulting. A stress-breaker, properly constructed, relieves the abutment teeth in function, allowing the mucosa and ridges to bear the burden of mastication, and thereby maintaining form, function and nutrition of these parts. By this means, these cases remain in functional occlusion, since the cause of absorption is removed and a stimulation that is conducive to good health is substituted. I have no pet type of stress-breaker, but would suggest that you select a type or two that will meet your needs and perfect yourself in their con-

struction in order to see the results at first hand. The perfect stress-breaker has not yet been made, and a great contribution can be made to partial denture construction by further work in this field. Even with their limitations, they contribute so much in this field of work that I would be at a loss should I not have access to their use. In Figures 10-13, a case is illustrated that is serving perfectly after seven years of use. This case was constructed for an upper jaw, with only three teeth for abutments, the remainder to be supplied by the partial denture. In the examination of this case, I can see only one reason for its success; namely, the stress-breakers, since the denture itself is heavy and has rigid cast clasps. The fact that in function there is no stress on the abutment teeth from the partial denture is the only reason for its long service. It has yet many years of real service, even though it has already served beyond my expectations. This and many other such cases have led me to press on to perfection in this field of correct balance and load distribution in partial denture work.

The next consideration is the type of material for the saddle and the area that it is to cover. Four things should determine our decision: the force to be applied; the weight of the fixture; a consideration of esthetics and the comfort of the patient. It is best to consider these four as one, since they are of equal importance. With the various materials at our call, we should be able today to construct cases that will meet these requirements with greater ease than ever in the history of our work. The alloys today in use have less weight per volume and are stronger than those of a few years back, lighter and stronger partial dentures thus becoming a possibility. With the improvements of the condensites, we are given opportunities to make restorations with clasps that belie their identity without increasing the weight of the finished pieces. Each case must of necessity be a law unto itself in the selection of materials and types of saddles. The area to be covered should be great enough to compensate the stress that is to be received in function in order that the health of these supporting ridges may be maintained. The covering of any greater area than this leads to a denture that is too heavy and reduces the comfort of wearing it.

The artificial teeth that are to be used depend wholly on the type of construction selected. In the posterior region, these teeth should be modified, not duplicating the teeth of a person 16 years old. Within certain limits, the buccolingual diameter should be reduced in all posterior teeth in order that the load on the saddle area may be reduced. The greatest reduction should be on the lower denture since its saddle area is less. I belong to the school that believes artificial teeth must be modified as to cusp form, in order to continue in service for any period of time. Dentures constructed with beautiful cusp teeth that interlock as an ideal set of teeth for the age of 16 are wonderful in esthetic value, but cannot serve the needs of a patient requiring partial dentures. In growing patients, lateral stress is necessary for growth and development of the jaws and dentures, but after growth is attained, the continuation of lateral force tends to cause the loss of tissue; hence, Nature takes care of that lateral stress in natural dentures by wear. In partial dentures, this wear must always be reproduced and the stress in function must be further reduced by lessening the area of the tooth that can be brought into occlusion. In increased vertical dimension, the remaining natural teeth in the posterior region should be made to

conform to this principle as far as possible without mutilation. In this manner, it is possible to reduce the load on each tooth, thus insuring longer usefulness. The number of teeth can be reduced in many cases, this reducing the load to be carried by the dentures and increasing the length of service to the patient.

In this paper, I have tried to outline the principles that guide me in my work. Observing work of other men as well as my own has directed me thus far. I am striving for perfection, and even though I realize that I am far from it, I shall continue to direct my efforts that way. The joys gained from bringing health and comfort to my patients causes me to press on in this great field. Dental cripples are greater in number than any one realizes, and if so many people are allowed to become edentulous, the world will lose confidence in our profession and many complicated problems will come to our attention that are unnecessary if we will only give more study and attention to the important problem of increased vertical dimension in partial denture construction.

# SIGNIFICANCE OF CALCIUM, PHOSPHORUS AND ENDOCRINE METABOLISM IN DENTISTRY*

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ORTHODONTIA, or facial orthopedics, in its relation and importance to pediatrics, has not received the consideration which it deserves. To its cause, our respective specialties must also seek the sympathetic response of the obstetrician, so that the teeth of the unborn child shall be anticipated and ample provisions for their welfare be instituted during the period of pregnancy.

A keener interest in the types of maldevelopment; a more thorough knowledge of the conditions that predispose to and accentuate deformities of the mouth, and a closer relationship between the interested professions are advocated, assuring our patients of concerted effort, carried out in a systematic and well-defined manner.

Tooth germs of deciduous incisors have been demonstrated in the embryo at 92 days; of first permanent molars, at 100 days; of dentin and a thin layer of enamel, at 164 days.[1] From the foregoing, one must conclude that oral prophylaxis must be practiced in the prospective mother and that no detail of her care should be overlooked. It is, therefore, obvious that conditions affecting the parent and secondarily the fetus will affect the deciduous dentition primarily, although the permanent tooth buds may ultimately be involved.

It is interesting to note that tooth formation precedes bone formation. Unquestionably, systemic disorders such as syphilis, tuberculosis and malnutrition, cause maldevelopment and, for this reason, the physical state of the prospective mother and the question of her nutrition must be paramount in the prophylac-

*Read before the Section on Orthodontia at the Seventy-Seventh Annual Session of the American Dental Association, New Orleans, La., Nov. 7, 1935.

1. Orban, Balint, cited by Rich, Celia: Prophylactic Care of Child's Mouth, J.A.D.A., 22:1592 (Sept.) 1935.

tic measures that are being advocated at this time. The masticatory musculature involves not only the teeth and dental arches, but the lips, nasal area, sinuses, tongue, palate, pharynx and throat as well. A change in metabolism, due to the state of nutrition, may implicate either one or all of the systems that constitute the human body. It would appear, therefore, that the establishment of a premise which favors scientific nutritional measures and obviates metabolic or deficiency diseases of the prospective mother, and necessarily of her child, should carry with it deductions more convincing than the theory, advanced in later years, that local conditions are responsible for decalcification and caries in the child. Were we to discount the foregoing, which seemingly is accepted at this time, how difficult it would be to explain rachitic deformities as resulting from systemic conditions and the dental conditions as the aftermath of focal infection. Irregularity, discontinuity and discoloration primarily involving deciduous teeth, and occasionally permanent teeth, are traceable to arrested development due to faulty nutrition and a change in metabolism. The permanent dentition will be delayed and the deciduous teeth will be lost prematurely. In turn, the mandible and periosteum will be softened, and it is my belief that the gums will be altered in their structure, owing to deficiency of calcium in the mandible and periosteum and of phosphorus in the gums.

My treatise will include a consideration of (1) calcium, phosphorus and endocrine metabolism during pregnancy and (2) calcium, phosphorus and endocrine metabolism in the new-born child, and up to adolescence.

## I

The embryonic period, the most important chapter of a child's existence, carries with it responsibilities of supervision that must be met scientifically and practically. What proofs have we that the expectant mother is entirely responsible for the increase of caries incidence and of maldevelopment that is constantly being brought to the attention of dentists and physicians? What retort can we offer when we are told that 96 per cent of the children of the United States of America have decayed teeth, whereas 98 per cent of the children of Southern Europe have perfect teeth?

Facts and not fancies, truths and not theories, successes and not failures must guide us. There are salient facts to be recognized regarding the mother during this period. It is not granted that she must have caries and gingivitis, with the usual sequelae; that salivary secretions need be altered because of the demand of the fetus for additional calcareous salts, and, finally, that for the birth of every child, the prospective mother must anticipate the loss of a tooth. Why seek additional evidence that the average prospective mother in the United States does not receive an adequate diet and, further, that sufficient estimates of inorganic salts have not been made? What is the burning sensation she experiences? Is it due to gallbladder disease or alterations in the gastric content? If there is marked achlorhydria, is the metabolism normal? On the other hand, if hyperacidity is evidenced, can we expect a negative balance of calcium? Are we certain that the endocrine metabolism is consistent with the state of pregnancy? Do we actually calculate her diet as regards calories, vitamins and types of food? Are we interested in knowing whether it is acid-ash or alkaline-ash in character? Are we conscious of food loss in the toxemia of pregnancy? Is it ever deemed necessary to make calcium-

phosphorus serum determinations? Are we not placing too much responsibility on the patient's judgment regarding diet and the ability of viosterol to metabolize calcium, which might be inadequate to meet the demands of the mother and the fetus? What is our knowledge of calcium and phosphorus with reference to their chemical combination and their distribution in food? What amount is necessary to meet the daily demands of the body and, finally, what recent experiments and deductions yield additional information that will aid us in our endeavor?

The newly born infant requires a calcium intake of 1 gm. a day; phosphorus, 1.5 gm. a day, and other elements in minor amounts: potassium, sulphur, sodium, chlorine, magnesium, iron and iodine, also traces of manganese, copper, zinc, lithium, fluorine, silicon and arsenic. Therefore, the pregnant woman must receive at least twice the amount allowable for the child in order to meet the exigencies of her condition. Calcium, together with phosphorus, is important in tooth and bone formation, constituting about 85 per cent, or at least three-fourths, of the entire ash of the body and consisting primarily of calcium phosphate. Phosphorus, a constituent of all nuclear material, is an essential component of every cell. The inorganic phosphates, as part of one of a group of phosphorus compounds of the blood, constitute a buffer system both of the blood and of the urine, trivial in the former, but extremely important in the latter. In addition, they aid in the formation of hydrochloric acid. No reference to the other physiologic functions of calcium and phosphorus will be made in this presentation. As there are a limited number of foods in which these elements are available, for the most part the supply of these metals must be sought in their natural distribution as foods and not in synthetic substances. It has sometimes been said that excess calcium may act as a depressant of the central and parasympathetic nervous system, in addition to increasing the tonicity of the uterus, but I seriously doubt that the indiscriminate administration of calcium in foods, or as dicalcium phosphate, to those who require it can have any untoward or grave complications. This, however, does not permit the use of viosterol. Observations since 1929[2] have not kept me from prescribing dicalcium phosphate in adequate doses, as I believe that this salt alone cannot be held responsible for either a hypercalcemia or a hyperphosphatemia, because, I have yet to record a single case wherein there were disproportionate amounts of these elements in the blood, though a thousand blood serum estimations have been made. Sherman (1926),[3] Berg (1911),[4] Bogert (1922)[5] and others express the belief that there is a paucity of

2. Bloom, C. J.: I. Secondary Calcium Phosphate Prevents and Cures Rickets Without Vitamin D. 1. Utilization Studies, Proc. Soc. Exper. Biol. & Med., 29:860-861 (April) 1932; II. Secondary Calcium Phosphate Prevents and Cures Rickets Without Vitamin D. 2. Calcification Studies, ibid., 29:861-863 (April) 1932; III. Secondary Calcium Phosphate Prevents and Cures Rickets Without Vitamin D. 3. Solubility Studies, ibid., 29:864-865 (April) 1932. Rickets—a New Treatment, South. M. J., 25:1109 (Nov.) 1932. Rôle of Calcium and Phosphorus in Prevention and Cure of Rickets, J. M. A. Alabama, 1:467 (June) 1932; Use of Dicalcium Phosphate and Inorganic Salts in Prevention and Cure of Rickets and Allied Diseases (Animal Experimentation), American Med. (Spec. Sect.), 39:6 (July) 1933; Calcium and Phosphorus Prophylaxis; Use of Dicalcium Phosphate and Diet, to be published.

3. Sherman, H. C.: Chemistry of Food and Nutrition, New York: Macmillan Co., 1926.

4. Berg, R.: Biochem. Ztschr., 30:107, 1911.

5. Bogert, L. J., and Kirkpatrick, E. E.: J. Biol. Chem., 54:375 (Oct.) 1922.

calcium in the American diet. This statement needs no reiteration for, in substantiating their opinions, one need only compare, for example, the diets of the United States with those of the Scandinavian peninsula, Denmark and the countries of Southern Europe. The physique, bony structure, perfect teeth and wonderful musculature of the people of these countries can evolve from one source; namely, a diet adequate in inorganic salts, with proper adjustment of the acid and alkaline ash foods. McCollum (1925, 1932)[6] writes:

> The optimum amount of calcium in a diet is still unknown. . . . Until recently I believed we were getting enough phosphorus but too little calcium. Now I am convinced that we need more of both of these substances . . . a simple way to supplement a diet poor in minerals is to take two level teaspoonfuls of dicalcium phosphate each day.

This amount of dicalcium phosphate will equal the calcium and phosphorus contained in a quart of milk. Occasionally, an alkaline food can, through prolonged cooking, be changed into an acid one, and it is also true that fertilization of the soil can alter, for instance, the copper content of vegetables. Consider what effect preservatives might have on canned foods—none other than the production of acid ions.

Granting that there are deficiencies in the diet of the mother-to-be, what oral manifestations will there be during pregnancy? Caries, gingivitis, engorgement and cyanosis of the gums, lips and all mucous membranes and, finally, perhaps the shedding of teeth. As teeth are closely related in chemical composition to bones, and since the minerals for the formation of such, especially calcium, must be obtained for the fetus through the mother from the food, or at her expense and, lastly, since Bar[7] estimates that the fetus requires 0.638 gm. of calcium a day, which far exceeds the entire intake for most American women, is not a tangible explanation offered for the oral condition of the pregnant woman? We interest ourselves in the health of the mouth and viosterol and yet disregard the diet. Viosterol may be a calcium mobilizer, but it has never been a calcium provider. The fact of its being capable of establishing a normal calcium-phosphorus balance in the blood, at the expense of the bony structure of the animal, was proved by Shelly, who fed rats a calcium-phosphorus free diet to which large and increasing doses of viosterol were added and was able to produce a hypercalcemia at the expense of the bony structure of these animals. Therefore, if the food supply of the prospective mother is deficient, the fetus will demand and withdraw the salts and other materials from her blood, bone and teeth, either with or without the aid of viosterol. Mazzacco, Krebbs and Briggs[8] have observed a dimunition of these elements in the blood of the pregnant as compared to the nonpregnant woman. Whether a lack of vitamin D plays a major or minor part in caries is, to me, a debatable question. My dependence on viosterol is of the past, as its usage has failed to protect and cure the conditions wherein its benefits were sought. This statement does not involve the integrity of vitamin D in cod liver oil or cod liver oil concentrates. If rickets and caries are affected by vitamin D deficiency, why is it necessary to give so much more of viosterol than of cod liver oil? DeSanctis

6. McCollum, E. V.: Newer Knowledge of Nutrition, New York: Macmillan Co., 1925; McCall's Mag., May, 1932.

7. Bar, cited by Reed, C. B.: Mouth in Pregnancy, J.A.D.A., 20:1631 (Sept.) 1933.

8. Mazzacco, Krebbs, and Briggs, cited by Reed, C. B.: Footnote 7.

and Craig's (1933)[9] deductions in this regard are most conclusive. It is therefore evident that, during the period of pregnancy, determinations of blood calcium and phosphorus should be made at regulated intervals and, at parturition, a blood chemistry test should be routine, because, from these deductions, deficiencies can be determined and necessary treatment be instituted from the day of birth.

By analogy, the engorgement of the gums of the mother-to-be has basically the same implications as the gingival condition seen in rickets and the bleeding of the gums recorded in scurvy. The deficiency is more liable to be that of phosphorus than that of calcium. In recent years, there have been an increasing number of articles pertaining to spasmophilia, convulsions and tetany in the newly born, and, only recently, Hellman and Rothstein (1935)[10] have brought to our consideration an article entitled "Low Calcium Tetany of the New Born as a Problem for the Obstetrician." I have seen a noticeable increase of these different types of lowered calcium concentration in the blood of the newly born, and it is my belief that these conditions are not so rare as has been thought hitherto. The diagnosis, which is essentially based on the low blood-calcium content, could be made if the blood serum determinations of the mother were followed. Hess, Lewis and Roman (1932)[11] think it quite unnecessary and of little value to feed large amounts of calcium and phosphorus during pregnancy. To this, I cannot acquiesce because, in the number of mothers, although the series is not yet so large, who have taken dicalcium phosphate throughout pregnancy, the absence of oral disease and the presentation to the child of beautiful pearl-white teeth have justified the usage of this salt. We are conducting a series of observations with control cases of twenty-five mothers who are receiving dicalcium phosphate during the pregnant period. A second group is receiving vitamin A and dicalcium phosphate and a third group cod liver oil concentrate and dicalcium phosphate. In addition, chemical determinations are being made on the teeth of those children who, for two years, received neither vitamin A nor vitamin D, in order to determine the mineral ash content of the same. In a series of twenty children who are now between the ages of 3 and 6 years, twelve of whom have been examined by dentists and eight by me, there is an absence of caries and disease of the gums, perhaps the direct result of the children's having received ample amounts of dicalcium phosphate from the age of 1 month.

There are two other factors not to be overlooked during the fetal period, perhaps not practical, and considered by some as inconsequential: the one, the determination of the gastric acidity; the other, the basal metabolic rate, of the prospective mother. Any marked variation of the $p_H$, or hydrogen-ion concentration, of the stomach, or minus and plus rates of extreme limits could, indirectly, affect the metabolism not only of food but of inorganic elements as well. The prospective mother's diet has been referred to as adequate, if such is possible. It is improbable that a standard diet can be tabulated for all mothers, for there are too many "ifs" and "ands." The obstetrician or dietitian must consider diet from the past health of the patient: caloric needs, fluid requirements, acid-ash and alkaline-ash foods, inor-

9. DeSanctis, A. G.; Craig, J. D., and Fales, H. L.: J. Pediat., 3:891 (Dec.) 1933.

10. Hellman, A. M., and Rothstein, J. L.: Am. J. Obst. & Gynec., 29:686 (May) 1935.

11. Hess, A. F.; Lewis, J. M., and Roman, Benjamin: D. Cosmos, 74:1053 (Nov.) 1932.

ganic salts and milk supply. Endocrine dysfunction, either of the hyperthyroid or the hypopituitary type, must receive consideration. In children, a diet that provided 1 gm. of protein per pound of body weight and a fatty acid to glucose ratio of 1:1 actually produced enamelization inside the pockets of carious teeth (Boyd and Drain, 1929, 1930).[12] For reasons heretofore mentioned, the diet for the expectant mother must be individual and not general, and must be written out. The public must pay more attention to diet as based on medical research than to the fads of Hay.

In a study of 1,250 basal metabolism tests, Hughes (1934)[13] found that, during pregnancy, there was a small increase at the sixth week, followed by a lowering in the second, third and fourth months; and thereafter a gradual increase to a plus quantity. Fifty-six per cent were within normal limits in the first trimester; 71 per cent in the second trimester and 75 per cent in the last trimester. It was also noted that the maternal weight increase was greater in the plus group than in the minus group and, vice versa, the weight of the babies was greater in the minus group than in the plus. Stander and Peckham (1926)[14] report an increase of 25 per cent in the total metabolism of normal pregnancy, but this is quickly adjusted to its previous level the tenth day after confinement. The increase usually occurs after the seventh month and is due, perhaps, to the presence of the fetus.

12. Boyd, J. D.; Drain, C. L., and Nelson, M. V.: Am. J. Dis. Child., 38:721 (Oct.) 1929. Drain, C. L., and Boyd, J. D.: Dietary Control of Dental Caries, J.A.D.A., 17:738 (April) 1930.

13. Hughes, E. C.: New York State J. Med., 34:873 (Oct. 15) 1934.

14. Stander, H. J., and Peckham, C. H.: Bull. Johns Hopkins Hosp., 38:227 (March) 1926.

II

Emerson (1930)[15] has sarcastically remarked:

> Nutritional disturbances in babies were first thought to be due to an excess of sugar in the diet; next to too much fat; then to faulty protein metabolism, so that the mother, omitting one element after the other, was left to the predicament of not knowing what food to give. In dentistry, when one has brushed his teeth seven times a day, has omitted sugar from his diet, has taken 2 ounces of cod liver oil, had filled up on cabbage and turnips and finished with a pint of orange juice, a rebellious stomach makes him realize that all is not well.

Our problem today is to prevent caries in the infant, which should be to a certain extent a protective measure for adults.

If the mother has proper nutrition during pregnancy, the probability is that the infant will have an ash content adequate for perfect tooth formation and sufficient to prevent osseous deformity or maldevelopment. I have always felt that thumb-sucking was often held responsible for deformities of the mouth for which it was not responsible. Admission is made that only ill can come from such an unsanitary, unnecessary and preventable habit. Primarily, the chemical content of the tooth and its fixture in the bone of the jaw and the condition of the gums are the primary activating triad responsible for a large proportion of the cases that seek orthodontic advice and correction. In order to obviate caries, pyorrhea, recession of the gums, etc., proper supervision must be instituted at the time the child is born, especially as relates to diet, and complemental food at various ages. The addition of cod liver oil or cod liver oil concentrates and dicalcium phosphate in adequate dosage,

15. Emerson, W. R. P.: D. Cosmos, 72:1147 (Nov.) 1930.

beginning with 1 dram in twenty-four hours in the proper food medium, with supplementation of orange juice and other foods at indicated months must be ordered, and orders must be followed. Nothing must be taken for granted. Accessory foods—cod liver oil and dicalcium phosphate—must be continued for at least two years. In this interim, oral prophylaxis must be practiced and, if possible, parents should be instructed that their children must have periodic dental examinations, preferably at 1 year, or thereafter. While I do not believe that vitamins play a leading rôle as far as the teeth are concerned, on the other hand the high alkaline-ash value of citric fruits should warrant their usage at an early age. It is accepted that orange juice, particularly, has, relatively speaking, a high calcium content. In the feeding of infants, when breast milk is not available, I have found reconstructed milk, especially "similac," and evaporated milks much more advantageous than modified cow's milk when dicalcium phosphate is used.[16] As the curd of cow's milk is essentially an insoluble protein, and as it is slow of digestion and includes in its makeup calcium and phosphorus, I have found that dicalcium phosphate cannot be metabolized in the same proportion as if it were to be added to milks having fine curds. Time does not permit my going into the chemistry of the digestion of milk, but recently there has been given to the profession another product called "soft-kurd" which has aided me in a limited number of cases when complemented with dicalcium phosphate. The addition of lactic acid to these formulas increases the availability of the calcium and phosphorus. For many years, there has come to my attention a group of infants who are difficult to feed, more or less exhibiting aversion to all foods and in whom no allergistic tendency could be demonstrated. As time passed and additional observations were made, and gastric determinations were held to be more conclusive, it was noted that these had an achlorhydria. With the addition of an acid, their appetites immediately improved. Faber (1935),[17] in ten patients between the ages of 7 months and 2 years with anemia of the nutritional or ion deficiency type, reported gastric analyses after the use of a histamine had demonstrated a marked secretory defect. Free acid was absent in six and low in four. Total acidity and volume were low in all the cases. Though my group was considerably larger than that reported, the findings coincide.

And now we approach the subject of caries. Galen (131-210 A.D.) believed that tooth decay was attributable to a disturbance in nutrition and, strange to say, today the same belief is held. Though there are many theories advanced as to the causes of caries, mere mention will be made of all those other than the two that are to be discussed. 1. Chemicoparasitic or chemicobacterial origin. 2. Calcium deficiency. 3. Phosphorus deficiency. 4. Calcium-phosphorus and acid-base balance. 5. Vitamin deficiency. 6. Salivary dyscrasia. 7. Endocrine disturbance.

Historically, whether we consider the Sioux and Iowa Indians of the Mississippi Valley or the natives of Punjab, a region of India, or the cannibals of the Samoan Islands, or the Wild Bushmen of Southwest Africa, if the basic diet has a sufficient calcium oxide and phosphorus pentoxide content and is high in alkaline ash, with meat included, there seemingly

16. Footnote 2, fourth reference.

17. Faber, H. K., et al: J. Pediat., 7:435 (Oct.) 1935.

is an absence of any structural dental change, namely, caries. It is accepted by those who have made both experimental and clinical determinations that phosphorus deficiency and an acid-ash diet are the contributing factors in caries formation. Klein and McCollum (1930, 1931)[18] definitely differentiated dental caries from developmental defects, the latter arising from deficiencies in calcium and the former from a lack of phosphorus. "Defective calcification may intensify, but never causes, caries. There is a casual but not causal connection between these two conditions."

In older children who have eroded teeth and cavity formation, the presumption has been that the present state of their teeth was due either to illness during the period of dentition or perhaps to indiscretions or irregularities or ill-balance of the diet. In many cases, this is not the history. Cases can be recalled wherein apparently healthy children had either discoloration of teeth or soft teeth that were prone to decay and ultimately to crumble. The picture would not be complete without the admission that there were a great many abscesses at the roots. Other children have been ill for many months of the first two years, with no prophylactic care of the teeth, and still with no evidence of caries. The plantation Negro had good teeth, probably owing to his diet of molasses and turnip tops, rather than to oral cleanliness. And, finally, to the hypo-acidity of the newly born child, we add the hyperacidity of the older child. In over 200 gastric analyses in children, the usual finding has been hyperacidity, especially marked in cases of hyperthyroidism with a metabolic rate in excess of plus 30. From expressions of others, we have learned that hyperactivity of the thyroid interferes with calcium and phosphorus utilization and that the continued presence of this marked hyperacidity can lead ultimately to the establishment of a negative calcium balance and in that way might be the forerunner of the pubescent period, which is the second era in one's life wherein cavities and decalcification are very much evidenced, or else may be continued into adult life.

18. Klein, Henry, et al.: Relation of Diet to Skeletal Development of Swine, Including Development of Teeth, J.A.D.A., 17:782 (May) 1930; J. D. Res. (abstr.), 11:484 (June) 1931.

## CONCLUSIONS

1. The cooperation of obstetrician, pediatrician and dentist is urged.

2. The period of pregnancy is of paramount importance to the child. The responsibility of management must be accepted by the doctor, and instructions to the mother-to-be should be clear-cut and written.

3. The complementation of the mother's diet with dicalcium phosphate must be routine. This food and prophylactic has prevented oral disease in the expectant mother, and has been basically responsible for an absence of caries in the deciduous teeth in children, in a large series of cases conducted by me for the past seven years.

4. The giving of calcium does not solve the problem. It is necessary to supply phosphate as well, and dicalcium phosphate is the most readily available salt.

5. In the older child, hyperacidity and endocrine dysfunction must be considered as possibilities in faulty calcium and phosphorus metabolism.

6. Caries and malformations can be prevented by an adequate diet, of proper alkaline-ash balance and with a bountiful supply of dicalcium phosphate.

# RÔLE OF FUSOSPIROCHETAL ORGANISMS IN ACUTE AND CHRONIC INFECTIONS OF THE MOUTH*

By DAVID T. SMITH,† A.B., M.D., Durham, N. C.

SPIROCHETES of various types, fusiform bacilli, spirilla, vibriones and cocci, are found in small numbers in relatively normal healthy mouths. When the gums are inflamed, these organisms increase enormously in numbers. Probably because of their ubiquity, they have generally been considered harmless saprophytes, or, at most, merely secondary invaders in tissues inflamed because of the presence of some other organism. I believe that this group of organisms is responsible for most of the acute infections in the mouth, playing an essential but not exclusive rôle in that most dreaded of dental diseases, pyorrhea. Furthermore, the fusospirochetal organisms of the mouth spread to the adjacent structures and infect the sinuses, eyes, ears, nose, esophagus, vocal cords, trachea, bronchi and lungs. They may be swallowed and infect the appendix and colon or be transferred by saliva-infected fingers to the skin and external genitalia. The presence of a fusospirochetal group of organisms in the mouth causes approximately 90 per cent of lung abscesses in adults, 50 per cent of lung abscesses in children and at least 50 per cent of bronchiectases. These severe and frequently fatal infections are all preventable by skilled dental treatment and oral hygiene.[1]

Several distinct species of oral spirochetes have been isolated in pure cultures and identified. *T. microdentium* (Noguchi) is a small spirochete with rigid coils. (Fig. 1, *I.*) It has the same cultural requirements and the same structure as *T. pallidum (Spirochaeta pallida)*. It is distinguished from *T. pallidum* by its foul odor in pure culture and its inability to stimulate in the patient a positive Wassermann reaction. It is not stained by the Gram stain, methylene blue, carbol fuchsin or thionin and will be overlooked unless the Fontana silver nitrate stain is used or the dark-field apparatus is employed. In many cases of chronic lung abscess and bronchiectasis and in some cases of pyorrhea and apical infections of the teeth, this is the only oral spirochete present. These cases will be reported from the laboratory as negative for spirochetes unless the special stain or the dark field illumination is used.

*T. mucosum* (Noguchi) resembles *T. microdentium* in structure, cultural reactions and staining properties. In pure cultures, it produces mucin in addition to the foul odor.

*T. macrodentium* (Noguchi) is a rigid-coiled spirochete, which differs

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1. Smith, D. T.: Oral Spirochetes and Related Organisms in Fusospirochetal Disease, Baltimore: Williams & Wilkins Company, 1932.

from *T. microdentium* by having larger and coarser coils. (Fig. 1, *II.)* There is a tendency for the ends to be tapered to a sharp point. Pure cultures do not have a foul odor. It is difficult to stain this organism with ordinary stains.

*T. vincenti* (Blanchard) *(Borrelia vincenti)* is only slightly larger and longer than *T. macrodentium.* It differs from that organism by its more rapid motility and by the irregularity of its coils, which form and re-form as the organism moves across the field. (Fig. 1, *III.*) *T. vincenti* can be stained faintly with Gram stain, methylene blue, thionin and dilute carbol fuchsin. It stains best with the same gentian or crystal violet that is used for the first part of the Gram stain. (Fig. 2, *I.*)

*T. buccale* (Luhe [Dobell]) is nearly twice as wide as *T. vincenti,* but resembles it in having irregular sinuous coils. Because of its width, it presents in the dark field a double outline, which immediately separates it from all the other oral spirochetes. (Fig. 1, *IV.*) This spirochete is easily stained with any of the aniline dyes. (Fig. 2, *II.*) Tunnicliff[2] found that this spirochete was developed from the large fusiform bacillus. I have confirmed her observation from cultures of my own. This spirochete as a spirochete and in its fusiform stage is readily killed by arsenic.

*Leptospira trimerodontia* is found occasionally in the human mouth. There is no evidence at present that it plays any part in disease. No one or no mixture of these spirochetes will produce infection in experimental animals.

Three types of fusiform bacilli have been grown from the mouth. The large fusiform bacillus (Fig. 2, *III)* that is usually present in great numbers in Vincent's infection of the tonsils and in acute oral Vincent's really represents a stage in the development of *T. buccale,* as explained above.

The second type of fusiform bacillus is similar to the first except that it is much thinner. This one is also present in Vincent's and other acute infections of the oral cavity. (Fig. 2, *IV.*)

The third type is shorter and thinner. (Fig. 2, *V.*) It is present in the more chronic lesions, such as chronic lung abscess, bronchiectasis, apical infection of the teeth and, in many cases, chronic pyorrhea. This small fusiform bacillus stains poorly with the usual dyes and is frequently overlooked. It is best demonstrated in very thin smears stained with gentian or crystal violet, and it is not affected by administration of arsenic. The fusiform bacilli alone and in combination with spirochetes failed to infect animals.

*Vibrio viridans* (Miller) has been isolated from the mouth. (Fig. 1, *VII.*) Small doses will not infect animals. Guinea-pigs die on administration of large doses; apparently from toxemia, since no local pus formation occurs.

Many kinds of cocci can be isolated from cases of pyorrhea: staphylococci of several types and especially streptococci of alpha, beta or gamma types. The alpha, or green, streptococci is most common. Most of the cocci are of low virulence and will not infect animals. Some strains of beta (hemolytic) streptococci produce severe infections consisting of a red cellulitis characteristic of streptococcic infection. This is quite different from the foul necrotizing lesions caused by the whole group of mouth organisms acting together.

A mixture made from pure cultures of *T. microdentium,* type 3 fusiform bacillus, *Vibrio viridans* and a hemolytic streptococci produced a foul necrotic lesion that could be transferred from

2. Tunnicliff, Ruth: J. Infect. Dis., 3:148 (March) 1906.

guinea-pig to guinea-pig in series. When some of the guinea-pigs were treated with neo-arsphenamine, the spirochetes disappeared and the lesion could no longer be transferred from animal to animal. From this and other experiments, I concluded that these infections were due to a symbiosis of anaerobic organisms. While the spirochete alone will not produce disease, it is an absolutely essential element in the symbiosis, and when it is eliminated by arsenic treatment, the infection subsides. It is probable that any one of the oral spirochetes and any one of the several types of cocci can combine with the fusiform bacilli and vibriones in initiating a symbiotic infection. Recently, Proske[3] repeated my cultural studies and confirmed the conclusion that a symbiosis including an oral spirochete is necessary to reproduce these foul necrotic types of infection.

Fig. 1.—Drawing made from dark field showing various types of mouth organisms: *I,* T. microdentium; *II,* T. macrodentium; *III,* T. vincenti; *IV,* T. buccale; *V,* fusiform bacilli; *VI,* S. sputigenum; *VII,* Vibrio viridans; *VIII,* cocci.

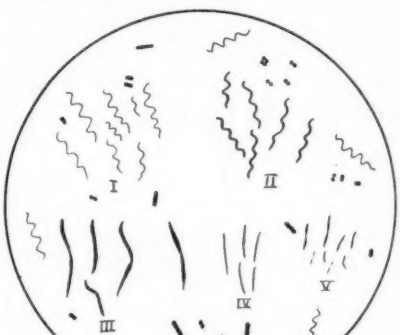


Fig. 2.—Drawing showing mouth organisms stained with gentian violet: *I,* T. vincenti; *II,* T. buccale; *III,* large fusiform bacilli; *IV,* medium sized fusiform bacilli; *V,* small fusiform bacilli; *VI,* cocci. T. microdentium and T. macrodentium are not stained with gentian violet.

3. Proske, H. O., and Sayers, R. R.: Pub. Health Rep., 49:1212 (Oct. 12) 1934.

I am frequently consulted in regard to the use of arsphenamines intravenously in the treatment of pyorrhea. Neither the intravenous nor the intramuscular injection of arsenic is entirely harmless. It is well known that severe and occasionally fatal arsenic poisoning follows it; hence, arsenic should never be used except in cases which have failed to respond to local treatment. Even in these cases, it should not be used alone, but in combination with a specific dietary régime and local dental treatment. Although intravenous arsenical therapy has been employed for years by dentists and physicians in the treatment of stubborn cases of pyorrhea, it has not been adopted by the more conservative members of either profession, because the ultimate results were not satisfactory, even when the immediate response was dramatic. I believe these failures were due to the use of arsenic alone by the physician and the

use of arsenic and local treatment by the dentist, with both ignoring the importance of vitamin and mineral deficiencies. Vitamins C and D, calcium, Goldberger's diet (pellagra preventive) and possibly vitamin A deficiencies may all play a part in the development of pyorrhea.

Guinea-pigs living on a well-balanced diet have a few fusiform bacilli, vibriones, spirochetes and cocci in the gingival crevice. Yet these animals never develop even a mild gingivitis. If the gums of these healthy guinea-pigs are inoculated with pus from severe cases of pyorrhea in man, an acute infection is produced, with swelling and even local necrosis, but the infection is always promptly eradicated and never becomes chronic. If the pigs are fed a diet that will produce chronic scurvy, after two to three weeks the gums become reddened and swollen and the attachment of gum to the teeth is loosened. The fusospirochetal organisms in the gingival crevice, which previously were harmless, slip into these crevices and find ideal cultural conditions in this anaerobic environment. The clinical picture of pyorrhea develops, as Wolbach and Howe[4] have shown. Pus from these gums show the same symbiosis of spirochetes, fusiform bacilli, vibriones and cocci found in pyorrhea in man. When the diet is supplemented by vitamin C in the form of orange or tomato juice, there is a reversal of the process, with complete regeneration of the gums.

Vitamin D and calcium will be discussed together, since both, in proper proportion, are essential for the maintenance of the cancellous bone that forms the socket of the tooth. This process has been studied by Grieves[5] in rats and by Jones[6] in dogs. When there is decalcification and partial absorption of the alveolar processes, a potential pocket is formed. The inadequately supported soft structures of the gum give way when traumatized by rough food, and an entrance for the fusospirochetal organisms is provided.

Patients with pellagra almost invariably have extensive infection of the gums with fusospirochetal organisms. In experimental black tongue in dogs, when all the known vitamins are supplied except Goldberger's dietary factor, the gums, cheeks and tongue become infected with the fusospirochetal group of organisms. The organisms seem to gain virulence by growing in the tissues, since typical foul abscesses can be produced in the groin of guinea-pigs inoculated with material from the mouth of dogs. Lung abscesses have been produced in dogs by intratracheal injections of pus from abscesses in the guinea-pigs. When the missing food substance or vitamin (pellagra preventive) is added to the diet, the infection gradually disappears, although defects are left if there was extensive destruction of the gums in the acute stage of the infection.

Vitamin A appears to be necessary for maintaining intact the epithelial structures of the body. When this vitamin is missing, infections occur with various types of organisms that would not be capable of infecting normal healthy tissues. I know of no direct evidence of the importance of vitamin A deficiency in fusospirochetal infections.

4. Wolbach, S. B., and Howe, P. R.: Arch. Path. & Lab. Med., 5:239 (Feb.) 1928.

5. Grieves, C. J.: Preliminary Study of Gross Maxillary and Dental Defects in Three Hundred Rats on Defective and Deficient Diet, J.N.D.A., 9:467 (June) 1922.

6. Jones, Martha P., and Simonton, F. V.: Proc. Soc. Exper. Biol. & Med., 23:734 (May) 1926.

Pyorrhea may develop about one tooth or about a group of teeth. This obviously cannot be due to a vitamin deficiency, which would affect all the oral structures uniformly. Calcareous deposits, bridge abutments and especially malocclused teeth will act mechanically by irritating the gum or loosening the supporting structures of the tooth to produce microscopic crevices, which are then invaded by the fusospirochetal organisms.

Administration of mercury, bismuth, lead and certain other toxic substances lowers the resistance of the oral tissues and allows a secondary infection of the gums with the fusospirochetal group of organisms.

Dietary treatment will prevent the development of pyorrhea in man by keeping intact the local mechanical defenses of the mouth, provided there is no external factor, such as malocclusion. Diet alone will not cure pyorrhea in man as it does in the guinea-pig. Dietary treatment with dental treatment will arrest the process in most cases. Recovery is more rapid if local antiseptics capable of killing spirochetes are employed. Many of the more severe cases will need intravenous treatment with arsenic compounds because the spirochetes are in the depths of the tissues, where they are protected from the local applications.

I have collaborated with the family dentist in the treatment of a number of the more severe types of pyorrhea. Several of the patients were so sensitive to the infection that every attempt to scale the teeth resulted in the development of an acute Vincent's infection with membrane formation on gums and cheeks. The patients had their usual diet supplemented with (1) one whole glass (90 c.c.) of either orange juice or tomato juice, three times a day after meals; (2) a tablespoonful of cod liver oil or two haliver oil capsules with viosterol 250D, three times a day after meals, the oil or capsules being taken with the tomato juice or orange juice, and (3) one glass of either sweet or butter milk, three times a day, to supply the necessary calcium. The remainder of the diet may be selected by the patient to suit his taste, provided it includes red meat or liver as often as three or four times each week, to prevent pellagra.

Neo-arsphenamine or sulpharsphenamine, from 0.2 to 0.3 gm., is administered intravenously the same day that the diet is prescribed. Sulpharsphenamine may be given intramuscularly. One week later, the arsphenamine is repeated. During the week following the second dose, while the tissues are saturated with arsenic, the dentist performs all necessary local operations. A third dose follows within a few days after the local operations. The diet must be continued for years, with frequent inspection, cleaning and local treatment rigidly enforced by the dentist. None of my patients have needed more than three intravenous treatments, and some have been under observation for as long as three years.

# VINCENT'S INFECTION*

By D. R. CLARK, D.D.S., Minneapolis, Minn.

THIRTY or more terms have been used to designate the disease that will be termed Vincent's infection throughout this paper.

Vincent's infection occurs in two major forms, acute and subacute, or chronic. Acute Vincent's is found in endemic and epidemic form.

The etiology of the disease is not proved beyond question. The usually accepted theory is Vincent's hypothesis, which concerns the symbiosis of the specific organisms, *Bacillus fusiformis* and the spirillum of Vincent. Two variations from this hypothesis exist: 1. The organisms are but different stages in the development of the parent organisms, with varying degrees of virulence in different stages of development. 2. These organisms produce a soluble toxic product, which, rather than the organisms themselves, is responsible for the pathologic changes. Other considerations of the causative factors in Vincent's are avitaminosis, scurvy, metallic poisoning and any systemic condition that might lower the resistance of the oral tissue sufficiently to permit invasion of the always present opportunist organisms *Bacillus fusiformis* and the spirillum of Vincent.

Bunting says that "since the clinical symptoms of the disease are never found in the absence of these organisms, although definite proof of the specificity of these organisms has not been forthcoming, the consensus of opinion today is in support of the view that the fusiform bacillus and its accompanying spirochete are at least essential factors in the production of Vincent's disease."

Practically all treatment of this disease has been directed at one or both of these organisms. It, therefore, becomes necessary to study the fusiform bacillus and spirochete of Vincent in detail.

*Bacillus fusiformis,* or *B. dentium,* is a spindle-shaped rod with pointed ends, varying from 1.5 to 4 microns in width and from 3 to 10 microns in length. It may be straight or curved. The bacillus has a granular appearance and stains irregularly with methylene blue, carbolfuchsin or gentian violet. It is gram negative and has from two to six visible granules distributed throughout the length. The bacilli are nonmotile and anaerobic.

Tunnicliff has cultivated the organisms anaerobically upon slants of Asiatic agar at 37.5 C. She found that, in such cultures, before the fifth day, bacilli only could be found, but that, after this time, spirilla gradually appeared and finally constituted the majority of the organisms in the culture. Tunnicliff believes from her study that the spirillum might be developed out of the fusiform microorganisms representing the adult form; a statement considered erroneous by Hiss and Zinsser.

The spirillum found in Vincent's infection is usually somewhat longer than

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the fusiform bacillus, being from 12 to 15 microns in length. The spirilla are made up of from two to five spirals, shallow and irregular in their curvatures, and are unlike the more regularly steep waves of *Spirochaeta pallida*. Vincent's spirillum stains evenly but less distinctly than the bacillus. It is considered feebly motile and is also anaerobic. During epidemics, the incubation period for these organisms has been estimated to be from twelve to twenty-four hours. Richard Dean[1] reports that "from cultural studies of the strain of spirochetes isolated from the blood stream, evidence of the existence of a filterable phase has been obtained." No other report seems to agree with this unproven and questioned contention. It is interesting to note, in this connection, that Vincent's infection has no effect on the Wassermann reaction (Puterbaugh) and that bacteriologists[2] state that the spiral forms of Vincent's have no relation to true spirilla.

Dean[1] writes:

> Stained preparations of the pseudo-membrane, found in Vincent's infection, contain great numbers of white cells, various kinds of micro-organisms and a dichotomous (two parts) branching type of growth which appears to yield mycelia and bacillary forms that are believed to be phases in the life cycle of the bacillus fusiformis. The mycelia constitute a network of fibers and make up the bulk of the pseudo-membrane. Within these meshes are fusiform organisms in all phases of development. Vincent's spirochetes, other organisms, blood corpuscles, epithelial cells, pus cells, serum and fibrin, are all matted together with food particles, débris and a ropy mucilaginous saliva.

1. Dean, R. D.: Summary of Observations on Cultural Characteristics of Fusospirochetes, J. Periodontol., 2:104 (July) 1931.

2. Varney, P. L.: Serological Classification of Fusiform Bacilli, J. Bacteriol., 13:275-314 (April) 1927.

It is generally accepted that the spirochetes invade the tissue to a very limited depth and that the fusiform bacilli remain on the surface, playing the part of saprophytes digesting the tissues that have been devitalized by the spirilla.

In considering the transmission of Vincent's infection from person to person, it is well to remember that this infection is not contagious but is infectious. All measures to prevent any infectious disease from spreading should be taken in Vincent's. No immunity is rendered by one or more attacks. Persons having chronic cases are potential carriers. The organisms *Bacillus fusiformis* and the spirillum of Vincent's are opportunists. Thus, any local or systemic condition that lowers the resistance of the local gum tissue predisposes that tissue to invasion, and to proliferation of these organisms, resulting in disease. Increased virulence and transplantation of the organisms from a normal location to an unusual region are two additional considerations in the transmission of this disease.

Vincent's infection may spread to other parts of the mouth or body by direct extension. The organisms of Vincent's infection have been found in connection with the systemic diseases of acute leukemia, pemphigus, hospital gangrene, pelvic peritonitis, industrial wounds, gunshot wounds, tooth wounds, brain abscesses and respiratory conditions. Systemic Vincent's infection is of importance to the dentist for the reason that the primary site is usually the mouth. An additional word may be appropriate concerning respiratory involvement. R. L. Haden writes:

> In view of the frequency of Vincent's infection of the mouth, its occurrence in lung pathology is exceedingly uncommon. One hundred and seven lung cases of all types were reported before 1927. However, typical Vincent's lung abscesses can be pro-

duced on experimental animals. It is, therefore, important to eliminate all trace of Vincent's infection before administering a general anesthetic.

The medication for these systemic cases has been symptomatic, with antisyphilitic injections as a shot in the dark. The high mortality in these cases indicates the worthlessness of this type of medication.

The clinical picture in acute Vincent's infection as seen in the mouth can hardly be mistaken for that of any other disease. The subjective symptoms are: pain wherever the ulcerating areas are found; malaise and general distress; fetid breath, and a temperature usually not over 101 F. The objective symptoms are: acute inflammation of affected parts; a distinct line of demarcation between the inflamed areas and the normal tissue; a necrotic gum margin presenting a ragged red appearance with loss of interdental papilla, and a pseudomembrane usually covering ulcerating areas. The removal of this membrane or the slightest irritation of the involved areas causes profuse bleeding. The glands of the throat may be involved, especially in children. Salivation may be present, and quick onset is characteristic. Smears for microscopic examination showing the presence of Vincent's spirochetes and the fusiform bacilli are aids to diagnosis, but not conclusive evidence in the absence of other symptoms. In chronic Vincent's, any one or all of the symptoms of acute Vincent's may be found in the variety of cases one sees. The usual symptoms are: chronic gingivitis; loss of interdental papilla, with hypertrophy of the buccal or labial and lingual portions; the presence of a pseudomembrane covering the ulcerating interdental areas; pain and spontaneous bleeding; hypersensitiveness of pockets to exploration; characteristic odor, and involvement of one or all interdental spaces. The presence of Vincent's organisms alone is not diagnostic, the history of the case being important in eliminating possible systemic complications.

The systemic complications that may simulate or complicate Vincent's infection are: metal poisoning from mercury, bismuth or arsenic; avitaminosis; agranulocytic angina; leukemia; pregnancy, and debilitating diseases, i. e., tuberculosis, diabetes and nephritis. If Vincent's infection does not respond to local treatment immediately, the diagnosis or treatment should be questioned and a general physical examination advised.

Nearly all treatment of Vincent's infection has been based on the bacterial theory regarding the disease. Treatment has included prophylaxis, destruction of causative organisms, building up of the local resistance of the oral tissue and the institution of general health measures.

The general considerations in treating active Vincent's infection are much the same in all technics of treatment. They include: (1) prophylactic measures with instructions to the patient concerning the nature of the disease and the precautions necessary to check its spread; (2) in severe cases, systemic medication for the elimination of toxemia by use of a light diet and a saline cathartic; (3) the elimination of tobacco and alcohol, thereby relieving the local oral tissue of two resistance-lowering elements, and (4) the elimination of mechanical irritations that cause lowered resistance of adjoining tissue.

The specific treatments of Vincent's infection reported in the literature include the use of: oxydizing agents (to destroy or inhibit the growth of anaerobic bacteria), such as chromic acid, 2 to 7 per cent, hydrogen peroxide and sodium perborate; caustics, such as Churchill's iodine and 35 per cent silver nitrate, chromic acid, trichloracetic acid and phenol; topical applications of specifics,

such as the mercurial, arsenical and bismuth preparations, and numerous other pharmaceutic preparations directed at the inhibition of growth or the destruction of Vincent's organisms; intravenous treatment, directed at the spirochete of Vincent; the ultraviolet rays; systemic treatment directed at avitaminosis, metallic poisoning and many other assumed causative factors.

Practically all technics recommend the daily use of an oxydizing mouth wash. These mouth washes, to be effective, should be used every one to three hours during active treatment. The accepted time of agitating the solution in the mouth is from two to three minutes. The oxydizing mouth washes, sodium perborate or hydrogen peroxide, inhibit the growth of the anaerobic organisms of Vincent's infection, deodorize the putrefying tissue and disintegrate the pseudomembrane overlying the ulcerating areas. Sodium perborate is sometimes prescribed for the reason that it is alkaline instead of acid in reaction, as is hydrogen peroxide. It has a tendency, on continuous use, to cause hornification of the epithelial surface of the oral cavity and has been reported as the causative factor in the development of hairy tongue. Mouth washes of the arsenical, mercurial and bismuth preparations are not so safe as sodium perborate or hydrogen peroxide solutions. Their use may result in metallic poisoning. A more serious consideration is their possible rôle as causative factors in agranulocytic angina. The prolonged use of any mouth wash is undesirable as mouth bacteria soon become tolerant of it.

Great variation of opinion as to office procedure exists regarding the use of topical applications and the systemic treatment of Vincent's infection. One group advocates bland medicaments for mouth washes and topical application and brand any and all other treatment as irrational. Another group insists that the only intelligent method of treatment is systemic injection of spirocheticides, and a third group advocates the use of caustics. All groups claim nearly 100 per cent success. The time and cost elements in the first group are an important consideration. The added expense of this type of treatment makes it prohibitive to some classes of patients. The second group, or those advocating antisyphilitic treatment, have little basis for their procedure. In spite of the fact that numerous cases of Vincent's infection have been reported in patients under antisyphilitic treatment, its advocates insist that the treatment is rational. In view of the fact that the Wassermann reaction is not affected by Vincent's infection, that the organisms have not been found in the blood stream and that the organism itself is not considered a true spirochete, one can hardly see the rationality of this treatment. Still further, when one considers the patient's inconvenience, the possibility of abscess formation at the site of injection, the possibility of agranulocytic angina and the fact that this treatment lowers the resistance of the gum tissue, this procedure seems irrational. When other simple local methods of treatment will bring about complete recovery from Vincent's infection, antisyphilitic treatment should be abolished. The treatment is based on a false premise and the only benefit that one can expect from its use is explained in the benefits derived from production of artificial fever, or a reaction similar to that produced by injection of a foreign protein; but it is by no means specific for Vincent's organisms. The third group, or those advocating the use of caustics, have a more rational basis for their treatment than has heretofore been recognized. Few question the remarkable

results obtained by the proper use of caustics in the treatment of Vincent's infection, but the objections to its use are many: the destruction of living tissue, the possibility of etching the tooth and the probable accompanying toxic effect on the patient. The advantages are: ease of application and the fact that it affords the quickest possible results, with little or no discomfort to the patient, and immediate relief of pain. The basis for the results seems to be the fact that the organisms do not penetrate the living tissue to any great extent, but are found as a thick mat just beneath the pseudomembrane. A strong chemical cautery destroys the organisms to the depth of their penetration of living tissue, leaving instead of an infected dead slough a sterile pellicle of tissue which sloughs off in from twelve to twenty-four hours. A clean healing tissue is left. Knowledge of the drug used is necessary, judgment in its use essential and care in its application imperative for success. The argument that a drug that destroys all living tissue with which it comes in contact is too dangerous for a dentist to handle is too foolish for words. The destruction of tissue is an advantage rather than a disadvantage in that it helps eliminate the pocket formed as a result of loss of interdental tissue. Things to be remembered in using a chemical cautery for the treatment of Vincent's infection are: that it is not to be applied to large open ulcers on the oral mucosa or tongue; areas should be isolated with cotton rolls and dried before application of chemicals; its use is limited to the free gum margins and interproximal areas, and one application is usually sufficient. The use of more than three applications three days apart is undesirable. It is unnecessary in acute Vincent's infection to use anything except an oxydizing mouth wash and neo-arsphenamine in topical applications until the infection becomes localized.

It is well to remember that bacteria acquire resistance to a medicament if treatment extends over a long period of time. There should be as little medicating as possible, for it is not so much the medicament used, but how it is applied, that brings about the speediest recovery.

The mechanical prophylactic treatment that accompanies medication is more important than the drug used in treatment of this disease. For rapid recovery, a painless progressive scaling should be instituted as soon as it seems proper. Wounds in the mouth, as in all parts of the body, heal faster if clean. Tooth brushing should never be stopped, but is rather advocated in chronic and subacute cases. In acute cases, the mouth is kept as clean as possible, brushing of the crown surfaces being instituted as soon as soreness and hemorrhage permit. Complete scaling and polishing of crown surfaces should follow.

As Vincent's infection does not cause formation of the so-called antibodies in the blood stream, one attack does not give immunity. Recovery and protection from the disease depend on the establishment of resistance of the tissues. Recurrent attacks of Vincent's infection may be eliminated to a great extent by removal of ill-fitting crowns and partially impacted teeth, elimination of overhanging margins on fillings and restoration of carious teeth and adjustment of occlusion. Special emphasis should be placed on thorough home care. Cooperation of the patient in home care is absolutely necessary for permanency of results. Home care (brushing of the teeth) builds up the resistance of the gum and eliminates the possibility of the development of pyorrhea in the areas left susceptible from the loss of interproximal tissue. Periodic prophylaxis is necessary to permanency of result.

# MALPOSED LOWER THIRD MOLAR: REPORT OF CASE

By NED LANDSMAN, D.D.S., New York City

A YOUNG white woman, of Bohemian extraction, came in for a dental examination because of a slight swelling on the face. There had been no concomitant pain at any time previous to the examination. The "swelling" was first noted twelve years previously, and, because there were no untoward symptoms, was promptly forgotten.

Clinical examination revealed a slight elevation or lifting of the skin together with the subcutaneous tissue. On palpation, a hard mass could be felt, but, on careful digital examination, the cusps of a crown of a tooth were easily felt. The occlusal surface was directed outward and downward.

The case is considered interesting because of its rarity.

340 West Eighty-Sixth Street.

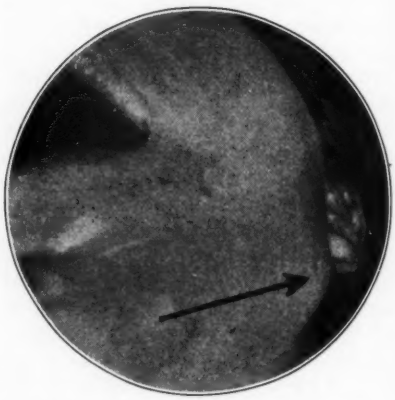

Fig. 1.—Appearance of area of swelling when patient opened mouth.

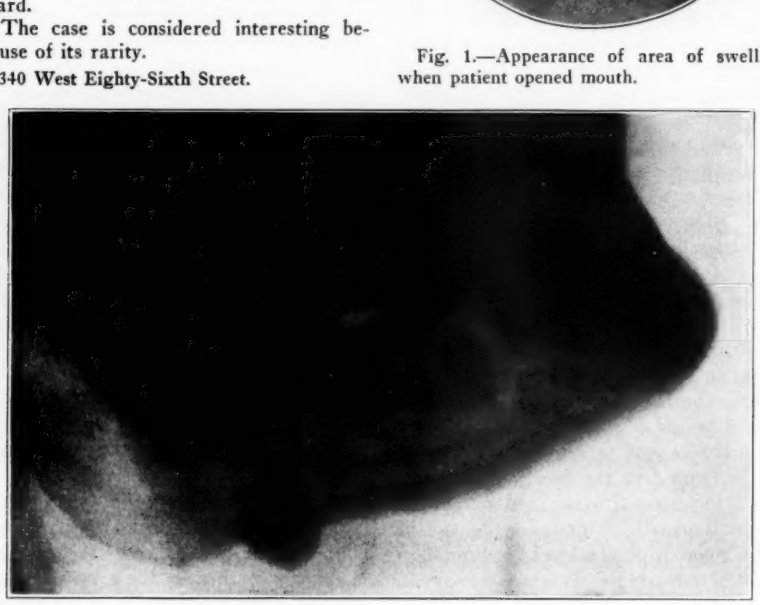

Fig. 2.—Roentgenographic location of molar.

# NEUROGENIC SARCOMA OF THE MANDIBLE: REPORT OF A CASE

By WELDEN E. BELL, D.D.S., Dallas, Texas

HISTORY.—A white woman, married, aged 65, came to the clinic April 8, 1935, with an edentulous mouth fitted with average dentures. The teeth had been removed fifteen years before. A small enlargement in the lower right second bicuspid and molar area was first noticed a few months after the original dentures were made. It was painless and very slow in growth. The original denture was worn over it for several years. From time to time, the lower denture was relieved over the area or remade to compensate for the growth, until, when the patient came in, a lower denture was being worn over a growth approximately one inch long and one half inch wide.

The immediate discomfort was due to irritation of the growth by the denture over a period of six weeks. During this period, a marked increase in size was noted, and the patient, becoming somewhat alarmed, called on a physician, who, in turn, referred the case to the clinic.

Careful history disclosed that the patient had suffered from neuralgia, this being one of the reasons that the teeth were removed. The neuralgia seemed to originate in the lower right jaw and had persisted for a considerable period after the teeth were removed.

*Examination.*—The growth was rather egg shaped. The surface appeared to be smooth, with two or three points of ulcerated mucosa (apparently from irritation by the denture). It seemed to be continuous with the mandible and had somewhat the outward appearance of a cyst. There was no crepitation. The structure underneath the smooth mucosa seemed irregular and rough on palpation. Aspiration disclosed nothing and the oral examination was otherwise negative. Nothing of an inflammatory character was present. A roentgenogram revealed a "bonelike" growth, not circumscribed and with no central radiolucency. Palpation of regional lymph nodes revealed a bilateral enlargement of the submaxillary and sublingual nodes and some of the cervical nodes. There was no pain nor tenderness present in any of these.

Appearance of growth.

*Treatment.*—Surgical interference was definitely indicated. A large flap was turned and the growth opened to view. Complete removal was followed by use of the phenol cautery.

*Pathologic Laboratory Diagnosis.*—Neurogenic sarcoma, grade 1 malignancy, was diagnosed on sectioning.

# The Journal of the American Dental Association

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C. N. JOHNSON, Editor

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## *Editorials*

### DENTAL SURVEY OF SCHOOL CHILDREN

A survey has just been published under the auspices of the Public Health Service that promises to be more comprehensive than anything of its kind ever issued. It is known as Public Health Bulletin No. 226, and is a survey of school children, ages 6-14 years, which was made in 1933-1934 in twenty-six states.

It was compiled under the direction of the late C. T. Messner, senior dental surgeon; F. C. Cady, dental surgeon; H. Trendley Dean, dental surgeon, and W. M. Gafafer, senior statistician—all of the United States Public Health Service, and was prepared by direction of the Surgeon General.

[It is considered only appropriate to state that the leading spirit in the preparation of this survey was Dr. Messner, whose untimely death on May 28 was a distinct shock not only to his many personal friends, but also to the Association as a whole. The galley proof of the survey came to the Editor's desk on the same day as the announcement of Dr. Messner's death.]

The following facts will be of interest in connection with this survey:

At the seventy-fifth annual meeting of the American Dental Association, held in Chicago in 1933, a resolution was passed that resulted in a dental survey of elementary-school children. The United States Public Health Service, having agreed to conduct this survey in cooperation with the Committee for Dental Health Survey of the American Dental Association prepared an examination form of which approximately 4,000,000 copies were distributed among state and local dental societies that had indicated a willingness to participate in the nation-wide survey. The completed examinations returned to the United States Public Health Service represented a total of twenty-six states.

The personnel of the Committee for Dental Health Survey were as follows: G. Walter Dittmar, A. C. Wherry, H. B. Pinney, and R. H. Volland, all ex-officio members; C. T. Messner, chairman, H. Trendley Dean, secretary, Homer C. Brown, A. W. Bryan, John P. Buckley, Harvey J. Burkhart, R. R. Byrnes, F. C. Cady, C. Willard Camalier, Frank A. Delabarre, G. R. Harrison, Thomas B. Hartzell, Frederick R. Henshaw, C. J. Hollister, W. H. G. Logan, F. H. Lum, Jr., A. R. McDowell, Albert L. Midgley, H. C. Pollock, Howard R. Raper, U. G. Rickert, J. B. Robinson, George H. Wandel, E. R. Warner and J. J. Wright.

In all, 648 counties were included in this survey and the result is a mass of material that has never before been brought together. The following states were included in the survey: Arizona, California, Colorado, Florida, Georgia, Indiana, Iowa, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Nebraska, New Jersey, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Dakota, Tennessee, Utah, Virginia, West Virginia and Wisconsin.

To indicate the amount of detail involved in this survey, it is only necessary to refer to a few of the tables. For instance, Table III gives the number of counties in which examinations were made in each of the twenty-six states, and classifies those counties according to the number of children examined; Table IV, the

number and percentage of children examined in the 648 counties, and Table X, the percentage of boys and girls of different geographic location, color and age, classified according to (*a*) present dental needs and oral disease and (*b*) past dental treatment.

It is quite fruitless to attempt anything like a comprehensive statement of the scope of this study in a single editorial, but it is safe to say that nothing approaching it has ever been undertaken.

Under the heading "Acknowledgments" the following statement is made:

> Thanks are due to the thousands of local dentists who ungrudgingly gave much of their time to the making of the examinations. Acknowledgment is made of the invaluable help received from the various cooperating state and city departments of health and of education, state and local dental societies, and the principals and teachers of the different schools in which examinations were made. Thanks are also due to the Rockefeller Foundation for a grant which made it possible to continue the arithmetical work connected with the survey. The authors are indebted to Surg. Gen. Hugh S. Cumming for creating the opportunity for the study, and for his stimulation and encouragement during its progress.

To every one of those who in any way have contributed to the preparation of this survey, the entire profession is under a deep debt of gratitude. Nothing like it has ever before been attempted in dentistry, and it will long stand as a monument to the energy and devotion of a large and representative body of men and women who have thus sacrificed their time and energy for the welfare of the profession and the people.

## TIME WASTED

Doubtless, most persons who are active and in the fullness of modern life would argue that they do not waste time. In fact, certain persons are forever rushing about apparently seeking to utilize every moment of their time in a frantic effort to make it count.

But this is not a correct conception of the proper employment of time. Time may be wasted by too much energy almost as surely as by too little. A methodical and orderly utilization of time one day with the other, one hour with the other, and even one minute with the other, constitutes the proper performance of

one's life work. To get the job done with the least useless expenditure of time and energy—that is the real problem for every one of us to solve.

In the practice of a profession like dentistry, wherein much of a technical nature is involved, there is frequently valuable time wasted through unnecessarily complicated and intricate procedure. To learn to eliminate false motion and needless detail is to save time that would otherwise be wasted. To systematize one's work is a time saver, though in this connection there is such a thing as straining so hard to introduce system and make oneself a slave to it that this very slavery constitutes itself an exaction that may be readily translated into a waste of time. In other words, there are certain persons who make such a point of systematizing everything they do in accomplishing a given object that they lose sight of the object in elaborating their system.

But probably the most disastrous waste of time is the expenditure of mental energy for the purpose, avowed or otherwise, of undermining the reputation of a fellow human being. Every fraction of a split second that is devoted to the undoing of some one else is time worse than wasted.

And when we think of the contentions that exist among men, and the amount of effort expended in futile disagreements over differences that for the most part amount to nothing in the real essentials of life, we can only marvel at the foolish waste that is everywhere about us.

The great men of the world have not wasted their time in this way. The men who have accomplished most for humanity, the men who have healed the heartaches of human kind, and made the pathway of life less painful; the men who have scaled the heights of human endeavor and pointed the way to a rarer atmosphere of high resolve and noble purpose; the men who scorn to stoop to the petty machinations of base and servile souls; the men in whose philosophy there is no taint of the propensity for "getting even"; the men who smile at persecution and ignore abuse; the men who sit serene while others rave and rant; the men whose souls are timed to the heavenly music of the spheres —have these men wasted their time?

Think of Savonarola, Epictetus, Marcus Aurelius. Think of Washington, Lincoln and Emerson. Think of Edison, Steinmetz and Marconi. Think of such men, and then wonder if their time was ever wasted.

## THE USE OF GLASS AS A DENTURE BASE

During the course of the last few years, a method has been developed in the Prosthetic Department of the Faculty of Dentistry in the University of Toronto for the construction of a denture base in a modified glass. By this technic, glass of suitable color and working characteristics can be pressed to the required shape in a manner very similar to present procedures in processing plastic bases.

There are many advantages in the use of this material as a base for artificial dentures. Among the more important are the following: The color is a pleasing tissue pink and remains exceedingly stable before, during and after processing. The technic, including repair and other alteration work, is simple, not critical in any way, and necessary equipment and supplies are not costly. In the mouth, it is odorless, tasteless and quite impervious, because it even seals itself securely to the porcelain teeth. There is practically no strain in it, and it can be sterilized in boiling water without fear of distortion. On the other hand, it will not stand impact any better than some of the current bases. This feature, plus that of slightly greater weight, is, apparently, the only disadvantage. To date, practical cases have been worn successfully for eighteen months.

Full details of properties and technic will be released for publication in the near future.

CLINTON T. MESSNER, D.D.S., F.A.C.D.
(1885-1936)

# *Obituaries*

## CLINTON THADEUS MESSNER, D.D.S., F.A.C.D.

**(1885-1936)**

Clinton Thadeus Messner, chief of the dental department, United States Public Health Service, died of coronary thrombosis, May 28, at his home in Washington, D. C. He was 50 years of age last October 13.

Dr. Messner was born in Oxford, Ind., the son of John C. Messner. He attended elementary school in his birthplace, where he started dental practice one year after graduation from the dental school of the University of Indiana in 1908. After two years in practice, he went to Portland, Ore., where he taught in the dental college there for two years. He then resumed practice in Oxford, continuing there until the entrance of the United States in the World War, for which he enlisted, receiving a commission as a lieutenant. He was discharged as a lieutenant colonel in 1919, and was thereupon appointed to the Public Health Service, being assigned to a post in St. Louis. In 1921, he was transferred to Washington, where he remained on active duty until the time of his death.

Dr. Messner was a former president of the Association of Military Dental Surgeons, secretary of the Research Commission of the American Dental Association and a member of the International Association for Dental Research, the New York Academy of Dentistry and the National Board of Dental Examiners. He helped to establish the first chair of public health ever provided for students at a dental college.

Dr. Messner was married to Edna B. Menfee, of Lafayette, Ind., June 24, 1909. She survives him, together with his mother, a daughter, Jean, and a son, Jack.

Interment was at Arlington National Cemetery, June 1.

## CHARLES W. HALL, D.D.S.

**(1867-1936)**

Charles W. Hall, a former Trustee of the American Dental Association, died June 10; aged 69. He had been ill for a year and a half.

He was born in Rio, Wis., and it was there that he entered practice after his graduation from the College of Dentistry, University of Michigan, in 1892. He went from Rio to Milwaukee, where he had been in practice for forty years prior to retirement because of illness.

In addition to his position of Trustee of the Association, he had been chairman of the Wisconsin Academy of Dentists, president of the Milwaukee County Dental Society and of the Wisconsin Dental Society and a member of the Milwaukee Odontological Society.

The widow, two brothers and two sisters survive.

Burial was in Forest Home Cemetery, June 13.

CHARLES W. HALL, D.D.S.
(1867-1936)

## CLAISON S. WARDWELL, D.D.S.

**(1856-1936)**

Claison Shaw Wardwell, a leading dental surgeon of New York City for nearly a half century, died in his eightieth year, April 16. He had practiced dentistry for sixty-one years.

Dr. Wardwell was born in Stamford, Conn. He attended Stamford Academy, and in 1874 was apprenticed to Dr. Elisha T. Payne. He graduated with honors from the Philadelphia Dental College at the age of 20, and with his brother, the late I. Franklin Wardwell, opened an office in Stamford. In 1878, he went to New York, where he practiced until his retirement, in February, 1935.

In addition to his successful pursuit of his profession, he was interested in architecture and mechanics, designing several houses, including his own, and inventing various dental instruments, including dental hammers employing compressed air and an improved electric dental hammer with jewelled bearings. He designed and built a boxkite for meteorologic purposes which won a prize, and another of his boxkites took the world title at the St. Louis Exposition. In his youth, he built for his own pleasure such devices as a telephone system, an inlaid violin, a steamboat, an engine and a tennis racket with which he competed in national tournaments.

The widow, a son and a daughter and two grandchildren survive.

## PRACTICE IN PARAGRAPHS

*This department is intended for busy readers. It aims to tell a vivid story in a few words. Items should be of a practical character, and free from padding—not more than a paragraph or two. We exact no limit, but two hundred words can tell most of these stories. Send in your ideas; they will be welcome.*

**Dropping Impression**—A blast of compressed air will cause an impression to drop without distorting it.—*C. C. Norris, Oshkosh, Wis.*

**Overhead**—Do not be discouraged if your overhead runs over 50 per cent. Many offices are running over 75 per cent.—*C. C. Norris, Oshkosh, Wis.*

**Balancing Books**—Balance your books daily and you know where your money goes. Also you do not have receipts handed you.—*C. C. Norris, Oshkosh, Wis.*

**Keeping Toothbrush Bristles Hard**—The addition of a few drops of ammonia to cold water will prevent the bristles of the toothbrush from becoming soft.—*A. Frackelton, Milwaukee, Wis.*

**Avoid Shock**—When applying any drug or remedy to a sensitive cavity, much discomfort to the patient can be done away with by having the medicament warm when it is applied.—*H. C. Heyen, Emmetsburg, Iowa.*

**Rest After Extraction**—After an extraction, unless the operation has been a very simple one, the patient should be directed to go home and rest. Going from the chair to a bridge party or on a round of shopping or any other form of exertion is obviously unwise, the consequent fatigue resulting in more than necessary postoperative discomfort and slower recovery.—*Edward C. Duryee, Peekskill, N. Y.*

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**As Others See Us**—Every dentist should take a few moments occasionally to sit down in his own operating chair and from that point of vantage look about for dust, grime and water stains on equipment which might otherwise be missed. Water stains in the cuspidor, lint and dust in the pulleys of the motor extension arm, spots on walls, woodwork and unit can be seen from the same point your patient sees them.—*Henry Stevens, Hart, Mich.*

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**Templet for Cast-Gold Restorations**—After the casting is trimmed and ready for polishing, a cast of hard plaster is poured and allowed to set for twenty-four hours, all overhanging edges first being trimmed. We now have a staple form on which to polish without having it caught by the brushes or buffers, and a key on hand to make adjustments of any accidental bending by the patient. The casting should be "teased" carefully from the stone model.—*C. R. Scholl, Reading, Pa.*

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**Impression**—A smooth mix of plaster is an important requirement of a good impression. To obtain this smooth mix, a very large rubber bowl is employed, in which the lumps are spatulated entirely out. The mix is very thin—what might be considered too thin. Just before spatulation, a pinch of salt is added. The bowl is rotated in a circular motion so that the plaster swishes around the sides of the bowl. Just before it is ready to set, the compound tray is dipped into the mix, which goes on evenly and smoothly.—*C. C. Higby, Clermont, Fla.*

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**Much in Little**—A good setting-up wax will save errors in the finished plate. The same applies to a hard shellac wax baseplate.—When a draw is not available, a piece of khaki cloth may be tacked on the under side of the bench and thrown over the lap when one is sitting at the bench, serving to catch things that are dropped and to keep clothes from being soiled.—Paper napkins are handy in the office and the little paper baking cups available at the ten cent stores are excellent for use as dapping dishes, especially for mixing cleaning tablets.—*Laurence G. Higgins, Ellsworth, Maine.*

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**A Good and Economical Lathe Pan**—Two "Ekco" bread pans Nos. 47 and 607 are hinged together at the narrow end with two wires, the wider pan (No. 47) being used for the bottom. A small hole is punched on each side of the bottom pan just under the rim and 4 inches from the front. A piece of stiff wire is passed through the hole and bent at the distance the pans are to be open while in use. The wire is looped to engage the upper pan and passed to other side. Another loop is made and the wire passed down through the hole on the other side of the bottom pan. The pans are painted with a black stovepipe paint to prevent rust.—*H. M. Flickinger, Siloam Springs, Ark.*

**Do Patients Appreciate Gold Foil?**—An enthusiastic old-time gold foil operator discontinued gold foil for more than two years because he believed patients did not appreciate his efforts. Life-saver Crissman of Detroit saved 148 persons from drowning and only three thanked him. Patients often express a belated thankfulness after enjoying the benefits of gold foil fillings for thirty or forty years. Patients must be educated as to the merits of gold foil. General practitioners who have devoted their entire dental career to gold foil fillings can look back on no other phase of endeavor so gratifying in a lifetime span at the dental chair.—*Herbert Ely Williams, Red Bank, N. J.*

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**Cementing Inlays**—Inlays should be cemented with the most nearly permanent cement regardless of color or shade. Extreme care in matching and blending the cement with the tooth is an admission of the shortcomings in inlay fitting. The amount of cement determines the fitting deficiency. If inlays fitted perfectly, no cement would be necessary. Anything fitted to an elastic medium must be oversize. It must be "too big" to be big enough. The more permanent qualities of an off color cement would offset the visibility of the cement line. Permanence is paramount and inlays are only as good as the cement which holds them.—*Herbert Ely Williams, Red Bank, N. J.*

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**Extraction Hints**—Having used several topical anesthetics for prevention of the pain of needle insertion, I am much gratified in being able to substitute the following: I determine by trial whether the patient can breathe easily through the nose. The site of the proposed injection is sterilized with a small swab carrying equal parts of tincture of iodine and of aconite. After a few seconds, the patient is asked to take a long, deep breath. At the height of inspiration, the needle is delicately but quickly inserted and injection is made slowly. When the extraction of a lower molar, particularly, leaves an open wound, the use of a curved eyedropper is prescribed for the patient's home use and he is instructed to flush out the socket after each meal, using a mild, nonirritating antiseptic. A mere rinsing of the mouth is not so effective. Keeping the food out will hasten healing.—*W. H. Savage, Clifton Forge, Va.*

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**Impressions of a Dental Assistant (by a Dental Assistant)**—No two dentists agree as to the qualifications of an efficient dental assistant. Some prefer a fine chair assistant, while others demand one expert in the casting of inlays, running of plaster models and the ordinary details incidental to the dental office practice. A good dental assistant should excel in versatility. Poise and dignity go hand in hand with a smooth running dental office; for, without these, the best chair assistant or laboratory helper can wreck an otherwise perfect office routine. A certain amount of self-assertion is needed in the handling of some patients, especially in trying to persuade them to part with that which really belongs to the dentist. Personal cleanliness and neatness are essential at all times. Tactfulness and a certain degree of friendliness in all telephone contacts will do much to soothe and take the "sting" out of many an irate patient. Any assistant possessing these qualities, together with an average versatility, will soon adapt herself to the requirements of the "general practitioner" and will become expert in all the phases of her duties.—*Mrs. Cecelia Clark, assistant to Herbert Ely Williams, Red Bank, N. J.*

# COUNCIL ON DENTAL THERAPEUTICS

## ANNUAL MEETING OF THE COUNCIL ON DENTAL THERAPEUTICS

**It is an established principle of the Council on Dental Therapeutics to advise the members of the dental profession and the public of its decisions as soon as circumstances permit. In accordance with this established principle, the following items discussed during the last meeting of the Council, which may be of interest to both dentists and manufacturers, are authorized for publication.**

SAMUEL M. GORDON, *Secretary.*

The Council on Dental Therapeutics of the American Dental Association held its seventh annual meeting at the Central Office, 212 East Superior St., Chicago, Ill., Sunday and Monday, March 29 and 30, 1936. The following members were in attendance: J. Howard Brown, Ph.D., associate professor of bacteriology, Johns Hopkins University, Baltimore, Md.; Paul J. Hanzlik, M.D., vice chairman of the Council, professor of pharmacology, Stanford University School of Medicine, San Francisco, Calif.; Thomas J. Hill, D.D.S., professor of clinical oral pathology and therapeutics, Western Reserve University School of Dentistry, Cleveland, Ohio; Milan A. Logan, Ph.D., instructor in biologic chemistry, Harvard Medical School, Boston, Mass.; Arno B. Luckhardt, M.D., Ph.D., Sc.D., LL.D., professor of physiology, University of Chicago, Chicago, Ill.; Harry Lyons, D.D.S., professor of periodontia and oral pathology, Medical College of Virginia, School of Dentistry, Richmond, Va.; John A. Marshall, Ph.D., D.D.S., professor of dental pathology and biochemistry, University of California, College of Dentistry, San Francisco, Calif.; Victor C. Myers, Ph.D., Sc.D., professor of biochemistry, Western Reserve University, schools of medicine and dentistry, Cleveland, Ohio; U. Garfield Rickert, A.M., D.D.S., professor of materia medica and therapeutics and hygiene, University of Michigan, College of Dentistry, Ann Arbor, Mich.; Harold S. Smith, D.D.S., chairman of the Council, 180 North Michigan Avenue, Chicago, Ill.; Samuel M. Gordon, Ph.D., secretary of the Council, Chief, A.D.A. Bureau of Chemistry, Chicago, Ill.; C. N. Johnson, D.D.S., LL.D., Editor of THE JOURNAL, Chicago, Ill., ex-officio member; Harry B. Pinney, D.D.S., Secretary, American Dental Association, Chicago, Ill., ex-officio member.

George A. Morgan, Trustee of the American Dental Association and a member of the contact committee between the Board of Trustees and the Council, was present on invitation.

Harold S. Smith and Paul J. Hanzlik were reelected chairman and vice chairman of the Council, respectively.

### STATISTICAL SUMMARY OF THE COUNCIL'S WORK

The Council was apprised of the numerical status of the products before it as of Feb. 1, 1936. The tabulation is given below for the interest of the members of the profession:

| | |
|---|---|
| Products announced in THE JOURNAL as accepted | 216 |
| Products announced in THE JOURNAL as not acceptable (including Notices of Judgment) | 273 |
| Products reaccepted (since April, 1935) | 11 |
| Products omitted from A.D.R. | 9 |

| | |
|---|---|
| Provisional acceptance and acceptance recommended | 62 |
| Acceptance not recommended, but still under consideration | 2 |
| Awaiting more evidence from proprietor for final disposition | 8 |
| Products acceptable, announcement delayed | 2 |
| Awaiting report of referee | 3 |
| Consideration postponed | 21 |
| Exempted list | 35 |
| Official drugs in A.D.R. | 120 |
| Products examined in the Bureau of Chemistry, findings not yet published | 63 |
| Total | 947 |
| Minus items 4 and 5 | 20 |
| Net total | 927 |
| Products discussed in answer to inquiries, etc., not including the foregoing, approximately | 850 |
| Total products brought to attention of the Council in one way or another | 1,777 |

Such statistical information, while indicative of the trend of the Council's work, does not represent the actual scope of the work being done by the Council or the work carried on in the Council's office. No mention is made of the large correspondence between individual members of the profession and the laity.

Other than the secretary, who also acts as chemist, there has been no technical assistance available since the latter part of 1932. Consequently, many important projects are being postponed until such assistance is available. Many chemical problems of a general nature of immediate interest to the dental profession, such as the examination of new proprietary products of potential usefulness, and an examination of many products that are being sold to the profession with an aura of secrecy and mystery, and that, as a rule, are not submitted to the Council, cannot be considered. The time available for work in the laboratory is such that only the most urgent examinations can be made. The Council, from time to time, has made an appeal to the governing bodies for funds for additional help, and it hopes that its pleas in this direction will soon be heeded.

As a result of the Council's endeavors, THE JOURNAL can now asseverate that it carries more reliable advertising than any other journal in dentistry. A member reading the advertising pages can be assured that the Officers of the Association have taken steps to secure a realization of the hope expressed by many dentists. The same cannot be said for some of the journals that are sent free to practically every dentist in the country.

The application of the policy laid down by the Association in 1930 regarding the requirement that only those products within the scope of the Council that are acceptable could be eligible for exhibit has been instrumental in meeting the dilatory tactics of some manufacturers of products acceptable in other respects than the advertising. Thus, several firms have come to recognize the desirability of marketing their products in an acceptable manner in order that their products may have attached to them the prestige that comes from exhibiting in the Association's Annual Session. Some manufacturers now consult the Council before placing new dental products on the market.

The work of the Council has led to an increase in the number of requests for courses in pharmacology and therapeutics by dentists. Such courses have been given in various parts of the country and many dentists have sought such instruction. It is gratifying to point out that, in all such courses, the place of the Council's work in securing a rationalization of the materia medica has been the basis of the course.

### ACCEPTED DENTAL REMEDIES

The Council has again noted with appreciation the reception of the second edition of the book Accepted Dental Remedies. It is still a matter of gratification that practically

every dental school in the country continues to require or recommend the use of the book in one course or another. Approximately 4,000 copies of the book Accepted Dental Remedies, 1935 have been distributed. More copies could have been disposed of were it not for the fact that the book was withdrawn from the market about April 1 in anticipation of the appearance of Accepted Dental Remedies, 1936.

Much of the information on actions and uses in Accepted Dental Remedies, 1935 can be carried without revision into the next edition of the book. The next edition will require extensive revision in order to harmonize it with U. S. Pharmacopeia XI and the National Formulary VI, which become official June 1, 1936. The official drugs listed in Accepted Dental Remedies will be reviewed for their continued usefulness and the nomenclature and other pertinent information in the official books mentioned will be followed in future editions of Accepted Dental Remedies.

Since the last appearance of the book, a number of proprietary articles that are not now listed in the book have been announced as acceptable through the pages of THE JOURNAL at various periods. They will be suitably edited and added to the book. Those proprietaries that have been declared not acceptable since publication of the second edition of the book will be added to the bibliographic index of those articles not included in A.D.R., so that, at the time of the appearance of the new edition, the owner of a copy of the latest edition of the book will have before him a statement as to the current status of all products considered by the Council for which reports have been published.

While the book is published as a service to the profession, and not for profit, it is gratifying to note that, in each instance, the sale of the book has netted a profit, which has been returned to the general funds of the Association. This indicates to the Council the willingness of dentists to support such a project as Accepted Dental Remedies.

The section on "Formulas and Prescribing Suggestions" was considered in detail by the Council. This section will again be carefully studied in order to bring it up to date as nearly as possible. There is always a question as to which formulas, or prescriptions, are most acceptable for given individual conditions. In the last analysis, the usefulness of the product depends on an understanding of the condition of the individual patient for whom medication is applied. This, and conformance to the principles laid down in the rules of the Council and explanatory comments thereon, will be the guiding principle in the revision of this chapter. The Council will give consideration to any suggestions that members of the profession may care to transmit to it, with the reason and any scientific evidence as to its usefulness.

It is the aim of the Council to base its decisions relating to the inclusion of material in Accepted Dental Remedies on either acceptable experimental or clinical evidence, as nearly as possible. The Council has no funds to grant to experienced investigators to carry out many of the studies that appear necessary in order to clear up moot questions that may arise in the preparation of Accepted Dental Remedies; but it has been fortunate in obtaining the interest of collaborators, in addition to the experimental work carried on by members of the Council. An associate of one of the members of the Council has already evaluated, by the blind method, the usefulness of topical anesthetics. Thus, the use of these agents is placed on a more scientific basis than has been the case formerly. Counterirritants, in the form of solutions or poultices, have been used in dentistry for a number of years. The evidence directly in support of such use is not available. Such an investigation is now being carried out by an investigator for the Council. The comparative merits of local anesthetics for hypodermic injection, by the blind method, is also the subject of an investigation by another member. The question of cold sterilization of instruments is one that has come up repeatedly. It appears to be a widely used practice in dentistry. Whether such a method is sound is, at the present time, open to discussion, although, to be sure, several drugs that have been used for this purpose with

claims of success are listed in Accepted Dental Remedies. A member of the Council reported on the preliminary results obtained with some of these preparations. Another member of the Council is carrying out extended experimentation on chlorate because of the questions that have been raised, but not satisfactorily settled up to the present, concerning its use in dentifrices and mouth washes. The question of "pain relievers" with potentially toxic properties, some of which have been advertised to the dental profession and to the public as being safe, is also the subject of investigation by a member of the Council. Other projects, such as an investigation by physiologic method of claims as to the deleterious action on the gums of the use of foods that do not require chewing must be postponed because of the inability of the Council to finance such an investigation.

The Council was apprised of the fact that a few dentists cannot realize the full benefits of Accepted Dental Remedies because they are in the habit of thinking of drugs in terms of proprietary names. For example, instead of thinking of the agents used in pulp capping under the terms of zinc oxide with eugenol, many practitioners, particularly of the older school, ask why Accepted Dental Remedies does not contain information on such and such a product advertised for this purpose. In order to meet this need as nearly as possible, the Council has suggested in the past, and has renewed its suggestion, to the governing bodies of the Association that a volume containing the reports of the Council on unacceptable products be published by the Council and the Association. Armed with such a book and with Accepted Dental Remedies, the dentist will be able to ascertain that such-and-such a product has, as its essential ingredient, zinc oxide. By referring to zinc oxide in Accepted Dental Remedies, he will be in a position to use the drug with due understanding of its uses and limitations, and, not the least important, with a monetary saving to himself and to his patients.

### BACTERIOLOGIC NOMENCLATURE IN ACCEPTED DENTAL REMEDIES

A standardized nomenclature is one of the prime requisites of science. It enables investigators and others interested in a field to be aware that they are talking of the same object. The American Dental Association is appreciative of this and has, as one of its special committees, a Committee on Nomenclature. Great progress has been made in the nomenclature of chemical compounds by the American Chemical Society, chemical terms applied to medicine by the Council on Pharmacy and Chemistry of the American Medical Association, and dental terms, through the Committee on Nomenclature of the American Dental Association. Bacteriologic nomenclature, because of the newness of the science, has not advanced the same degree as some of the other fields mentioned. It is the desire of the Council to have Accepted Dental Remedies conform to acceptable bacteriologic nomenclature. This was studied by a member of the Council, who presented the following statement:

The need for the adoption of a more practical and scientific classification, or nomenclature, for bacteria is brought out in the following quotations.

About 1905, H. Marshall Ward wrote: "The only really valid objection to a purely scientific classification is the old objection of the purely utilitarian practical men; and even there the objection is relative. This leads me to bring out the point that the bacteriologists in the widest sense of the word are really looking at the question of classification from at least two very different points of view: On the one hand, we have the botanists, who direct their attention to the organism, the *Schizomycete* itself, as a biological phenomenon to be examined and reported upon as thoroughly as possible. For them no classification is complete which does not record, or (which amounts to the same thing) imply in its records, all of the life phenomena of the organism, including its pedigree.

"On the other hand, we have the pathologists, hygienists, brewers, chemists, etc., who regard the organism simply as an object to be named for convenience in reference, because

it brings about certain changes in tissues, waters, and other media which they are more especially concerned with. They do not care, and naturally so, what vagaries the organism exhibits, so long as they can recognize it when they meet with it. As a matter of experience, however, it is just these vagaries that bring about the sources of error which beset them on all hands, and hence they are equally interested with the botanist in having them cleared up and explained. When we come to the conclusion that, whatever may be believed to the contrary, the real interests of bacteriologists of all kinds are identical."

In Jordan's "General Bacteriology," eleventh edition, 1935, it is stated: "The current nomenclature of bacteriology may be criticized on two grounds: First, as already pointed out, for the unwieldy size that certain 'genera' have been allowed to assume; and second, for the haphazard way in which trinomial and even quadrinomial names have been bestowed. Such names can be properly employed only with reference to subspecies or varieties; and designations like *B. coli communis, Granulobacillus saccharobutyricus nobilis nonliquefaciens,* and *Micrococcus acidi paralactici liquefaciens Halensi,* are both cumbersome and unscientific. The use of a single generic name for a multitude of organisms is, in fact, responsible for the tendency toward trinomial nomenclature, and the remedy for both conditions would seem to lie in the frank establishment of new genera on the basis of morphologic and physiologic characters as rapidly as general international agreement can be reached. Until some such reform in nomenclature is brought about the names used to designate different kinds of bacteria will fail to make clear the group relationships which undoubtedly exist, and will continue to be a stumbling block to all students of the subject."

When early bacteriologists recognized three distinct morphologic types of bacteria, namely, cocci, bacilli and curved or spiral forms, they had little appreciation of the fact that in each of these morphologic groups, there were organisms of such widely different physiologic characteristics that it would become necessary to distinguish many different genera on physiologic rather than morphologic grounds. In the groups of higher plants and animals, it is seldom necessary to consider physiologic differences, but these have assumed primary importance from the very beginning of the science of bacteriology. In the rapid development of the science of bacteriology, it was the activity of bacteria in disease and in bringing about chemical changes of industrial importance that was of primary interest. It was therefore natural that such fathers of the science as Pasteur and Koch gave little attention to the classification and nomenclature of bacteria and were satisfied to employ names that coupled the simple morphologic designations with one or more descriptive terms which indicated their physiologic or pathogenic activity. As a matter of fact, there had not yet developed any basis for a more rational or detailed classification. It is probably for this reason that the indiscriminate use of the word "bacillus" as a generic name has been handed down to the present time and that, when so used, it has become so inclusive as to have lost all significance except in designating a rodlike organism. In spite of historical sanctions, this is a situation that cannot continue indefinitely, and the longer it continues, the more difficult it becomes to discard the older nomenclature and to adopt a newer and more rational nomenclature.

Although many persons have proposed systems of classification of bacteria, and some of these efforts have met with considerable acceptance for the time being, it is doubtful that any of these proposals have met with the acceptance accorded those of the Committee of the Society of American Bacteriologists in their final report of 1920. These suggestions have been subjected to modification and further development by other authors since 1920, but unquestionably they constitute a milestone in the development of bacteriology. This classification is recognized, and often adopted, in most of the recent textbooks on bacteriology published in English, sometimes quite consistently, as for instance in the "Text-Book of Bacteriology," by Ford, 1927; "Principles of Bacteriology and Immunity," by Topley and Wilson, 1929; "Pathogenic Microorganisms," by Park and Williams, 1933;

"General Bacteriology," by Jordan, 1935; "Laboratory Methods of the U. S. Army," by Simmons and Gentzkow, 1935, and "Agents of Disease and Host Resistance," by F. P. Gay and associates, 1935. In other textbooks, this classification is recognized even though the nomenclature may not be so consistent throughout, as, for instance, in the "Text-Book of Bacteriology" by Zinsser and Bayne-Jones, 1934. Bergey's "Manual of Determinative Bacteriology," now in its fourth edition (1934), is based upon the 1920 report of the Committee of the Society of American Bacteriologists. It may be said, therefore, that the adoption of this classification and nomenclature is making rapid progress. It is employed in the textbooks that medical and dental students are using and the reference books and bacteriologic journals that dentists and medical men must read. Although it may at times be inconvenient for the older dentists and medical men to acquaint themselves with the newer terminology, it is less inconvenient than to require dental and medical students and the younger bacteriologists to resort to an older and less informative terminology. I believe that, at the present time, the Council is in a position to offer considerable encouragement toward the progress of bacteriologic nomenclature by adopting the motion proposed, at the same time clarifying its own attitude on problems in bacteriologic nomenclature, which must arise constantly. The Biological Section of the American Drug Manufacturers Association, with the approval of the National Institute of Health, has now under consideration the substitution of the newer generic names of the bacteria, to be used in their labels and literature, for the older names now in use by them, having the newer names followed by the older names in brackets. It would seem, therefore, that the time is opportune to take some action.

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On the basis of this statement, the following motions were adopted:

1. *(a)* That the Council recognize as acceptable for the nomenclature of bacteria the generic names proposed in the Final Report of the Committee of the Society of American Bacteriologists on Characterization and Classification of Bacterial Types (J. Bacteriol. 5: 191, 1920); (*b*) that these names be used in A. D. R. and other publications of the Council; (*c*) that the use of "common names," not used in a generic sense, and the use of newer names for subdivisions of the genus *Bacterium* be also permitted, and (*d*) that this action shall not preclude the use of names of products required in government licenses when used as such on package labels, in package enclosures, in advertising, in reports of the Council or as headings for descriptions of products in A. D. R., provided such names are followed by names acceptable to the Council.

2. That the Council request the Editor of THE JOURNAL to consider favorably the adoption of the revised bacteriologic nomenclature that has been adopted by the Council for use in publications of the A.D.A., and that this request also be transmitted to the Committee on Nomenclature of the A.D.A.

[Abstracts of the Final Report of the Committee of the Society of American Bacteriologists on Characterization and Classification of Bacterial Types are available to those interested, on application to the Council office.]

### CHLORINE-LIBERATING PREPARATIONS

Chlorine-liberating preparations in aqueous solutions decompose on standing. Since such solutions for therapeutic use are generally made up on the basis of the amount of available chlorine present, the matter of labeling assumes importance to those who use these preparations, or are charged with regulatory acts. It was decided that products subject to deterioration, in order to be acceptable, should be labeled with a statement of composition at the date the product leaves the manufacturers, and that a supplemental statement be made either indicating the percentage of deterioration or the actual minimal amount at the end of a specified time.

GERMICIDAL SOLUTIONS FOR COLD STERILIZATION OF INSTRUMENTS

It was mentioned above that requests for information on solutions of chemicals for the cold sterilization of instruments come to the Council. A.D.R. carries information on certain of these that have been used in the past. Some of these are various solutions of formaldehyde, various preparations of mercury salts, various preparations of phenols, to mention a few. The subject has not received the investigation that its widespread use would indicate.

In consideration of certain proprietary products submitted to the Council, a referee undertook an investigation, which is still underway. This investigation included examination of several preparations that have been compounded in the A.D.A. Bureau of Chemistry. While some of these solutions are able to kill bacteria under certain conditions, the work has already indicated the difficulty of killing bacterial spores. It was provisionally concluded that the claims made for solutions of chemicals for the cold sterilization of instruments should be accepted with reservations until more information than is available at the present time is at hand. The Council regrets that it has not available a sum of money for a grant to a competent worker to undertake an examination of this important project.

CALCIUM COMPOUNDS

In the course of the year, the Council published a report on "Calcium and Phosphorous Compounds in Dentistry." After an extensive review of the literature, the Council concluded that there was no evidence available to warrant the use of these compounds for the prevention or treatment of dental caries, and concluded that many of the claims now currently being made for the usefulness of such products were without acceptable foundation. The Council also drew up reports on specific proprietary products, which were sent to the manufacturers marketing them. In no case did any manufacturer submit evidence to cause a revision of the Council's position, but general statements were made as to the presumed lack of calcium in the American diet.

After a consideration of these products, the Council concluded that no scientific evidence has been presented to warrant the reversal of the position of the Council on Dental Therapeutics on the nonacceptance of these products for A.D.R. As far as this Council is concerned, these products, to be acceptable, must have proven value as a prophylactic in the treatment of dental caries. No evidence has been presented that the addition of mineral supplements of calcium phosphate beyond that present in an adequate diet will prevent, overcome or retard dental caries. If and when acceptable evidence is presented demonstrating that supplementing the diet with compounds of calcium and phosphorus will favorably influence the incidence of dental caries, the Council will be glad to consider the admission of these products to A.D.R.

*(To be continued)*

# BUREAU OF PUBLIC RELATIONS

## WHAT IT MEANS TO BE A DENTIST*

By L. E. BLAUCH,† Ph.D.

Editor's Note.—Dr. Blauch is not a member of the dental profession; he is an educator who has recently devoted four years to an extensive study of dental education in the United States and Canada, under the direction of the American Association of Dental Schools. He speaks from his observation of the training and activities of men and women engaged in the practice of dentistry.

THERE is no disease or ailment that plagues humanity more nearly universally than two very common diseases of the mouth, decay of the teeth and pyorrhea. So common are tooth ills that I may address all of you as fellow victims. Moreover, I may surmise that you, along with practically every other person, have at some time had experience with a dentist. Probably, you have talked with other persons about what he has done for you, and they have told you what dentists have done for them. In all this experience and conversation, you have learned something about the dentist's services; you have come to understand what it means to be his patient. Have you ever inquired or learned just what it means to be the dentist?

You may care to know something about this man and about the profession. I shall explain, therefore, (*a*) the purposes of dentistry, (*b*) what the dentist does, (*c*) how men and women become members of the profession and (*d*) the standards and organization of the group.

### PURPOSES OF DENTISTRY

One hundred and sixty years ago, when the American Declaration of Independence was signed, dentistry was regarded as a handicraft that was carried on by skilled mechanics. Dentists received their training, as did other craftsmen, through apprenticeship. The young man who aspired to a mastery of the art attached himself to a practitioner. He watched this man serving patients and helped him in his work, and, after a period of personal observation, assistance and instruction, he established an office and undertook to carry on a practice of his own.

Since those early days, a great change has occurred in the outlook of dentistry and in the methods of training dentists. The profession now has two principal purposes: (*a*) to care for the physical health of people and (*b*) to promote their mental health and happiness. Let me explain them.

The teeth and the mouth are subject to a great number of diseases, some of which the dentist can prevent and treat very satisfactorily. Moreover, the teeth and the mouth have significant relations

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to the rest of the body. The importance of proper chewing of food as the first step in digestion has been emphasized by studies of physiology and nutrition. Then too, it has been found by physicians that common disorders of the teeth and gums produce serious, often fatal, ailments in other parts of the body.

These considerations have led dentists, physicians and others to regard dentistry as a most important service for maintaining physical health. They are responsible for such statements as those made by Dr. William J. Mayo, who said that "many of the degenerative diseases of middle life are of dental origin" and that "the dental profession can add ten years to human life." The late Sir William Osler, one of the eminent physicians of his day, wrote, "There is not one single thing in preventive medicine that equals mouth hygiene and the preservation of the teeth." Dr. A. C. Fones, a leading American dentist, has stated that "dentistry, perhaps more than any other profession, has the knowledge and the opportunity to practice true prevention." In fact, today one frequently hears dentistry referred to as a phase of preventive medicine. The important relations of dental health to the general health of the body have led Dr. Herman N. Bundesen, president of the Chicago Board of Health, to say that the next great problem in public health is the adequate care of the teeth of children.

Another great purpose of dentistry is to promote the happiness and mental health of people. It is a service in mental hygiene. Dentistry does this through assisting people to maintain a good facial appearance and, in some instances, through improving an unattractive facial appearance. Hardly anything imposes on one a greater social handicap than does a set of ill-formed or unsightly teeth or the loss of teeth, if the condition is not properly cared for. Such a person is likely to be shunned by others, and he finds it difficult to take his part in a group. Because persons so afflicted are at a social and an economic disadvantage, it is natural that they tend to brood over their misfortune and become morose. They may even develop a feeling of inferiority and worthlessness. To promote the happiness and mental health of people through maintaining good facial appearance is then one of the important purposes of dentistry.

These two purposes of the profession have placed the dentist in a strategic position and revolutionized his practice. He is now regarded as a doctor who prevents and treats diseases and disorders of the teeth and mouth. He is no longer looked on as a mere mechanic; rather, he is a practitioner of a profession that protects and promotes mental and physical health. To be sure, he extracts teeth and performs such mechanical operations as filling teeth and making artificial teeth, but, in doing these things, he is treating dental disease, preventing disease in other parts of the body and preserving the mental health of his patients.

Many people do not yet comprehend the important health services that the dentist renders, largely because they do not see people die of diseases of the teeth and gums. They fail to realize that rheumatic fever, a kidney disorder or a serious heart disease may be caused by the presence of infected teeth. There are on record many cases of persons who died from ailments whose origin was in the teeth and gums. Moreover, people do not always understand the rôle that adequate dental care plays in preventing chronic and gradually debilitating diseases, which reduce physical vigor, impair efficiency and lower resistance to disease, all of which cut short one's productive years.

WHAT THE DENTIST DOES

Because of his great responsibilities, the dentist is called on to do many things. You will be interested in some of them.

Among his duties are those that relate to the prevention of dental disease. At periodic intervals, he makes thorough examinations of the teeth and mouths of patients to detect the beginnings of disease so that it may be dealt with before much damage has been done. He cleans and polishes teeth to eliminate irritation of the gums and prevent pyorrhea. He educates his patients as to how they can keep the teeth and gums in good health. The prevention of dental disease is a responsibility that must be shared by both the dentist and the patient: neither can carry it alone.

The dentist's services to children are of special importance, for decay of teeth occurs more frequently, progresses more rapidly and does greater damage to health in childhood than in later life. Furthermore, the effects of dental disease in childhood often continue throughout life. For example, the loss of one or more permanent teeth in early life, which is a common occurrence, may alter greatly and permanently the appearance of a person. If dental decay is reasonably well controlled in early life, dental care is much simplified in adult life. Few persons reach manhood or womanhood with all the teeth present unless, from early childhood, they have received the regular attention and service of the dentist, which includes both care and training. Not the least of these services consists in explaining to parents how they can cooperate in helping to develop good teeth in children and save those teeth for the important work that they have to do.

Dentists do a fine service in straightening crooked teeth. You may have heard the name for this work: it is called orthodontia. It is difficult; in fact, it presents so many problems that a large proportion of the dentists prefer to leave orthodontic service entirely to dental specialists in this field. In the future, we shall undoubtedly hear much more about this service than we do at present.

Every dentist is expected to make thorough examinations and diagnoses of dental conditions in his patients. Until recent years, this service was greatly neglected. Fortunately, the x-rays, with their startling disclosures of mouth conditions, have become a most significant aid in the examinations that he makes. You may be interested to know that a dentist, Dr. Edmund C. Kells, pioneered, and indeed lost his life, in perfecting x-ray films and adapting them to dental and medical uses. Well-trained dentists are now able to render excellent diagnostic service.

A considerable part of the dentist's work consists of treating teeth showing decay (caries). He does this by cutting away the diseased parts and placing fillings in the cavities. When the decay has progressed to the point where the dental pulp (the nerves and blood vessels in the tooth) has been exposed and become infected, he is confronted with a special problem. Sometimes, it is best to extract such teeth; at other times, they can be saved by skilful treatment.

Certain phases of surgery of the jaws and mouth, particularly the extraction of teeth, constitute a part of the dentist's work. Fracture of the jaw bones and dislocation of the lower jaw are commonly treated by him. He also cares for certain types of wounds and injuries. The more extensive types of surgery in the mouth are usually performed by specialists known as oral surgeons.

You will observe, then, that the dentist is a surgeon. In one respect, he goes farther than the surgeon usually does. His work has not been completed when he

has removed teeth from a mouth. He does what he can to overcome the crippled condition of his patient by providing substitutes.

The modern dentist has become skilful in minimizing pain, in many instances eliminating it altogether, while he performs operations on the teeth and gums. In fact, dentists have led the health professions in the discovery of methods of controlling pain. Two of them, Dr. Horace Wells and Dr. William T. G. Morton, about ninety years ago discovered that surgical operations could be performed without pain to patients who were put to sleep with nitrous oxide or ether. Later, dentists made extensive use of drugs that kill pain without putting patients to sleep. More recently, a dentist has discovered a drug by which much of the pain from having teeth filled can be eliminated.

The idea that dentistry is a health service has led naturally to cooperation between dentists and physicians. This cooperation works both ways. Physicians call on dentists for aid in diagnosing ailments in which disease conditions of the teeth and gums may be a factor. Frequently, dental treatment helps greatly to clear the body of an infection. At the same time, dentists call on physicians for aid. The dentist occasionally finds that his service to a patient requires a comprehensive medical examination. Sometimes, he discovers in the mouths of his patients signs of the onset of cancer of the mouth or signs of disease in other parts of the body, such as diabetes or anemia. By recognizing such indications of disease and referring the patient to a physician, he renders an excellent preventive service.

Dentistry has come to occupy an important place in public health work. Members of the profession are taking an increasingly large part in municipal, school and industrial hygiene. In this work, they are associated with physicians in harmonious cooperation to care for the health problems of the community.

You will observe that the dentist is called on for a variety of services, all of which are directly or indirectly related to the physical and mental health of their patients and the public. Let me say, incidentally, that dental service as rendered in the United States and Canada is now regarded by many persons as the most proficient in the world. This is due largely to the efforts of certain men who in the past laid the scientific foundations of dental service and to the excellent dental schools in these two countries.

### HOW MEN AND WOMEN BECOME DENTISTS

You will be interested to know how men and women become dentists. The education of prospective dentists begins with several years in college. Many of these young people graduate from college before they begin the study of dentistry. Their next step is to enter a dental school, where they take an extensive course of four years. Here they study a number of sciences, learn several technical subjects and acquire experience in the school clinic.

The sciences taken by the dental student are similar to those taught in medical schools, because the problems in dentistry are similar to those in medicine. He learns the structure and functions of the human body; the nature, causes and progress of disease, and the treatment of human ills; all of which are directed to the purpose of making a competent practitioner.

Another extensive group of subjects that the dental student learns deal with the diagnosis and treatment of diseases of bone and the soft parts of the mouth, with straightening teeth, with filling

teeth, with crowns and bridgework and with artificial dentures, commonly called "false teeth," or humorously called "store teeth." In order that he may render these services, the dentist must know much about the structure and function of the teeth and the mouth and about the maladies to which they are subject; he must understand what constitutes facial comeliness, and he must learn to work with fine precision.

A large portion of the last two years of the dental course is devoted to work for patients in the clinics of the dental schools. Here, the student observes conditions found in the mouths of people, learns to diagnose dental diseases and acquires considerable ability in preventing and treating dental disorders. Moreover, he develops a keen sense of responsibility for his patients.

Finally, after four years of study and clinical practice, he is graduated, provided the faculty is satisfied that he can be trusted to do professional work without supervision. He receives the degree of doctor of dental surgery (D.D.S.) or doctor of dental medicine (D.M.D.), depending on which school he attended.

You will probably want to ask how much a dental education costs. We can offer a close estimate. On the basis of such information as is now available, it is fair to say that the cost to the student, including the cost of his preliminary college education, amounts to $5,000 or more—in some cases, to as much as $8,000. These figures include living expenses during the time he is in college and dental school.

Although graduation from dental school is an achievement, it does not immediately admit a student to practice. Before he may begin his life work, he is required to pass a comprehensive and exacting examination, which is given by the state board of dental examiners. This ordeal requires several days. If he satisfies the examiners that he is capable of serving patients in accordance with the standards of modern dentistry, he is given a license.

After the young graduate has been licensed to practice, he is confronted with the problem of establishing an office. This requires an outlay of between $2,000 and $3,000—in some cases, considerably more—and usually he has a period of months during which he has only a few patients and little income.

### THE DENTIST A PROFESSIONAL MAN

The dentist is a professional man, and he is under obligations to conduct himself accordingly. His relations with patients are personal; and they are based on confidence—confidence in his professional competence and in his personal integrity and trustworthiness. The usual standards of the market place do not obtain in his practice. Salesmanship and barter, as they are understood in commerce, are foreign to his traditions. To be sure, economic considerations may not be neglected, for he has financial obligations that he must meet; but they cannot be his ruling principle. Truly, "the laborer is worthy of his hire," but the size of the dentist's fee is not an index of the quality of his service. He has no trade secrets: he shares his methods of service freely with other practitioners. In short, as a professional man, he is engaged in making available to society a highly specialized service that meets an important human need, and he does this on a basis of proving equal and true to the trust that patients place in him.

The dentist is one of a group of 70,000 persons in the United States who are members of his profession, about 1,300 of whom are women. This group of people is well organized in local and state societies and national associations, all of

which exist for the improvement of the profession and the protection of the public. If he lives and practices according to the high standards of professional responsibility demanded by these organizations, he is likely to be a member of one or more of them. He keeps up to date in his methods of service by reading dental periodicals, of which there are many, and by attending professional meetings. He may continue his study of dentistry through participating in study clubs and taking postgraduate courses in dental schools.

### CONCLUSION

What then does it mean to be a dentist? The answer can be summarized in a few statements. First, it means that he is a doctor whose services are aimed directly at the preservation of the health of the teeth and mouth and indirectly at the promotion of the mental and physical health of his patients and the public. Secondly, it means that he is a highly trained and professionally responsible person who has spent a long period of time in the pursuit of a difficult course of study as a preparation for his life work. Thirdly, it means that he has passed a rigorous examination by a state board of dental examiners and has been licensed to practice. And finally, it means that he is a member of a large and well-organized professional group that establishes standards of ethical practice and cultivates and promotes the art and science of dentistry.

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### A.D.A. Exhibit at the International Dental Congress

The Bureau of Public Relations has prepared a 40-foot exhibit, which will be displayed in the American Dental Association section of the International Dental Congress in Vienna in August. This exhibit will give European dentists some idea of the services which the American Dental Association is rendering the profession and the public. At the conclusion of the Vienna meeting, the exhibit will be retained in Europe for further education purposes.

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### Dentistry for the Expositioners

The millions of visitors at the three major expositions held this year will be given ample opportunity to absorb some of the rudiments of dental education. Dental exhibits are on display at the San Diego Fair, the Texas Centennial at Dallas and the Great Lakes Exposition at Cleveland. Practically all of the Bureau of Public Relations' exhibition pieces and models have been loaned for the summer and fall seasons to these three large expositions. Even so, the Bureau did not have material enough to supply the demand. Thanks to the generosity of the University of Southern California, Washington University, Northwestern University Dental School and Western Reserve Dental School, all three expositions have been supplied with an acceptable dental exhibit. In addition to supplying dental health educational material to the three large fairs, the Bureau of Public Relations has furnished exhibit material to thirty-nine state and component societies.

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### "Your Teeth and Your Baby's Teeth"

The little booklet "Your Teeth and Your Baby's Teeth," prepared by the Bureau of Public Relations early last winter, seems to have supplied a long felt want. The first edition of 10,000 is exhausted, and the second edition is going fast. If you haven't ordered your supply, do so now. The booklet is advertised on page A-26 of this issue.

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### What the A.D.A. Is Doing for Its Members

Twelve attractive red and black exhibits portraying some of the services rendered by the American Dental Association were

developed by the Bureau of Public Relations this spring. Each exhibit, which is 5½ feet high by 30 feet long, consists of eight sets of large black cardboard panels on which are mounted in red statements regarding some of the services rendered by the Bureau of Public Relations, the Library Bureau, the Council on Dental Therapeutics, the Committee on Economics and the Relief Commission. These exhibits will have been displayed at thirty state meetings during the spring and summer.

### "Answer Your Own Dental Questions"

One hundred thousand copies of the novel, concise dental health chart "Answer Your Own Dental Questions" have just come off the press. Look in your Events Program for your copy. By means of a revolving disk, superimposed upon a 6 by 8 inch cardboard background, the laity can secure the answers to twenty-four common dental questions. You will want a quantity of them for your office. Turn to page A-24 of this issue for a description and prices.

### Guggenheim Dental Clinic's New Movie

The Bureau of Public Relations has just received a copy of a new 16 mm. motion picture entitled "Modern Care of Children's Teeth," recently developed by the Murry and Leonie Guggenheim Dental Clinic in New York City. The film contains some excellent views of the institution and the work which it is doing for the poor children in its vicinity. Preschool and school children are shown entering the clinic, being assigned and being examined. Several good closeups of roentgenograms of deciduous teeth, defective mouths, extreme decayed conditions in 2½ and 4 year olds, and irregular teeth and malformed jaws in children of school age are presented. The concluding views, which are of the dental hygiene school, show the student hygienists in the classrooms and laboratory teaching mouth hygiene to the children.

### Public Health Bulletin 226

Members of the American Dental Association will be pleased to learn that the report of the dental survey of school children made in 1933-1934 by the United States Public Health Service and the American Dental Association is ready for publication. Originally scheduled to be released about June 15, the bulletin may be delayed somewhat by the untimely death of Dr. Messner. On page 1352 of this issue, an editorial presents the purpose of the survey and outlines the contents of the report. Every member of the Association should have a copy. It can be secured from the U. S. Public Health Service or the Superintendent of Documents, Washington, D. C.

### Do You Know That

Of the two important causes of death, tuberculosis and cancer, the death rate for the former has been steadily and consistently down for the past five years, while that for cancer has been just as steadily and consistently up.

The parents, and not the baby, should be spanked when the child indulges in tantrums, crying, whining, or thumb-sucking, said Professor Christine Heinig of the Child Development Institute of Columbia University, the other day. "When Johnny does not behave properly, that's a sign that something is wrong," Professor Heinig said. "If the parents can't find the root of the trouble, they should seek some one who can give them educational guidance."

For two years now, Manchester (England) school dentists have succeeded in persuading children to submit to necessary treatment by the employment of a powerful inducement—a refusal to give any treatment, even for toothache, where treatment

had been refused at the previous yearly inspection.—*D. Mag. & Oral Topics.*

More than 25,000 dental cases in Salt Lake City elementary school children have been handled by the Dental Service Society since its initiation in January, 1934, it was reported by R. C. Dalgleish, president, at a meeting of the board of directors. Samuel G. Paul, city school health officer and a director of the association, said that early surveys had shown that approximately 78 per cent of elementary school children were in need of dental attention. A recent survey of sixth grade students showed only 28 per cent in need of care, he said, expressing his opinion that most of the improvement is due to the work of the Dental Service Society. Dr. Dalgleish said approximately half the operations have consisted of amalgam fillings of a permanent type. The work now is being extended to include junior and senior high school students and children of preschool age.

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## AMERICAN DENTAL ASSOCIATION

## ON

## COLUMBIA BROADCASTING SYSTEM

Monday, July 13

From Station KFRC, San Francisco, Calif.

3:00 p.m. Eastern Daylight Saving Time

2:00 p.m. Central Daylight Saving Time

12:00 m. Mountain Time

11:00 a.m. Pacific Coast Time

SPEAKER: George B. Winter, President of the American Dental Association.

SUBJECT: "Organized Dentistry's Contribution to Humanity."

You and your friends are invited to tune in on Dr. Winter's message.

# DENTAL ECONOMICS

## SURVEY OF DENTAL PRACTICE IN FOREIGN COUNTRIES

DURING the past six months, the Committee on Economics has conducted a survey of the practice of dentistry in foreign countries. While this survey is not completed, to date replies have been received from sixteen of the thirty countries to which questionnaires were sent.

A copy of the questionnaire together with the replies is presented herewith:

PRACTICE OF DENTISTRY IN FOREIGN COUNTRIES

1. What are the requirements for the practice of dentistry in your country?
2. What additional requirements does a dentist licensed to practice in the United States need in order to practice in your country?
3. Is a dentist who wishes to practice in your country required to be able to speak and write your native language?
4. Do you have reciprocity with any other countries? If so, please name them.
5. Kindly send us a copy of your dental law, preferably an English copy if you print them.

AUSTRALIA

1. Any person who proves to the satisfaction of the board that he is of good character shall be entitled to be registered as a dentist if he:

(*a*) Is a graduate in dentistry of any university in Australia or of a dental college affiliated with a university in Australia; or

(*b*) Is a holder of a diploma or degree in dentistry from a university in any country, whether British or foreign (other than Australia), which diploma or degree is recognized by the dental board as at least equal to the degree of bachelor of dental surgery in the University of Sydney.

(Certain other requirements are also necessary. These will be forwarded on request.)

2. Same as above.
3. Only English spoken.
4. Yes, under certain conditions stipulated by the Act of 1934.

BAHAMAS

1. A candidate for registration in the Bahamas as a dentist, who is in possession of a diploma obtained in the United States of America, is required to satisfy the government medical board on the under-mentioned points before his application can be considered by the governor-in-council:

(*a*) That he is a graduate of a Dental College classed as A.

(*b*) His identity.

(*c*) His personal character.

(*d*) His professional ability.

The registration fee is about $26.

2. Must have graduated from a Class A school.

3. A dentist wishing to practice in the Bahamas is not required to be able to speak and write the native language.

4. There is no reciprocity with any other country.

BELGIUM

1. To be licensed in dental science.

2. A dentist licensed to practice in the United States must have the following additional requirements:

(*a*) Be authorized by the minister of the interior.

(*b*) Be domiciled in Belgium.

(*c*) Attach the original American degree to the request to the minister of interior.

(*d*) Own a federal degree, if such is required in the U. S.

(*e*) Have attestation from U. S. government showing that the degree is valid for practice in all states of the Union.

(*f*) Have attestation of an authorized board (similar to our provincial medical boards) that he has attended during two years a stomatologic clinic and actually practiced surgical dentistry.

(*g*) Have all above mentioned documents legalized by our diplomatic agents.

(*h*) Be of *exceptional scientific attainments,* and furnish proof that it is of public interest to grant such a permit.

3. A dentist wishing to practice in Belgium should be able to speak French at least. This is not officially required.

4. Belgium does not have reciprocity with any other country.

BERMUDA

1. Application to the colonial secretary, who then consults the Board of Trade and the Board of Immigration. The Dental Board examines the applicant, who must be a graduate of some recognized dental school approved by the board.

2. [A communication from the chief immigration officer informs us that as there are numerous dentists already practicing in the colony, any application from a nonresident of Bermuda to enter the colony for the purpose of engaging in the practice of dentistry would not, in the circumstances, receive the favorable consideration of the immigration board.]

3. No such ruling at the moment.

4. Bermuda has no reciprocity with any other country.

HONG KONG, CHINA

1. In Hong Kong, the dental law is practically the same as that of England and the preference is given to British graduates.

2. Dentists must be graduates of Class A college and have passed a state board examination in the state in which he graduated. They must have sufficient personal recommendations from home and from Hong Kong, after which the dental board recommends or rejects him as a person to practice, final action being taken by the governor.

3. Hong Kong is a British Colony and it is not required that the applicant be able to speak the native Chinese.

4. There is no reciprocity with any other country.

PEIPING, CHINA

1. At present, Peiping has two types of practitioners: the graduates of qualified Chinese and foreign dental colleges and the apprentices. The former can apply for a license without examination. The latter require an examination for the license.

2. The applicant must apply for a license and submit his credentials to the health authorities.

3. Yes, if practicing among Chinese patients.

4. No.

DENMARK

1. Successfully pass Danish dental examination and serve two years as assisting dentist.

2. Successfully pass Danish dental examination.

3. Not only required, but also necessary because of the Danish examination.
4. No.

ENGLAND

1. Practice is limited to duly registered medical or dental practitioners. The penalty for infringement is a fine not exceeding £100. A dentists' register is maintained by the Dental Board of the United Kingdom. Admission to register is based on proof of holding a registrable dental qualification.

2. Applications for registration of foreign qualifications are considered on their individual merits and no definite rule is laid down other than that they must meet the requirements in force for the time being. (Sections 9 and 10, Dentists Act 1878.)

3. No.

4. There is no reciprocity, but British qualifications entitle to practice in most British possessions, and most qualifications granted in British possessions are recognized in Great Britain.

FRANCE

1. An applicant must take the "Titre D'etat" corresponding to a U.S.A. State Board.

2. Additional requirements include the French Government diploma.

3. The applicant must be able to speak and write French as the examinations are given in French.

GERMANY

1. In Germany, dentistry is practiced by the:

(*a*) *Zahnartzen.* (Conditions: finished higher education and completed study; preliminary examination after three semesters and state examinations after additional four semesters.)

(*b*) *Dentisten.* (There are no generalized educational requirements. In social insurance, only *Zahnartzen* are included.)

2. A dentist licensed in another country can practice dentistry in Germany only if he takes the German state examination.

*Dentisten* can practice without an examination.

3. Knowledge of the German language is not part of the law, but a foreign dentist could hardly get along without knowledge of German.

4. No reciprocity with any other country.

*Zahnartz* in Germany corresponds approximately to the American D.D.S. The *Dentist* in Germany is something of an advanced laboratory man whose status has never been completely clarified and whose activities depend largely on the existing political and economic conditions.

GUATEMALA, C. A.

1. (*a*) To possess the degree of graduate in sciences and arts.

(*b*) To be of mature age.

(*c*) To present the degree originally obtained in a university which is duly authorized.

(*d*) To have the degree duly legalized by the consular agents (attorneys) of Guatemala in the place where the degree was obtained.

(*e*) To have the degree legalized in Guatemala in the Department of External Relations and in the Department of Public Education.

(*f*) To present an application of incorporation to the Department of Public Education.

(*g*) To prove duly the personal identity of the applicant.

(*h*) To give information regarding his character, and be known to be of unquestionable honor as evidenced by his conduct during the year previous to ap-

plication. (When an applicant is a foreigner, his character and good conduct shall be investigated by diplomatic functionaries or consuls of Guatemala.)

(*i*) To pay the corresponding fees of an examination.

(*j*) To pass an examination in theory and practice, in the Castilian language, on all the subjects which in Guatemala comprise the profession of dental surgeon.

(*k*) Having passed the examination, to obtain a license for practice in the General Administration of Public Health.

2. This question is answered with the explanation in the previous paragraph.

3. Yes.

4. Reciprocity exists only for native Central Americans who obtain their original degree in Central American universities.

An excerpt from the organic law, National University of Guatemala, is as follows:

1. Entrance to the country shall be restricted.

2. Those who come to seek work in commercial establishments, farms or industries or devote themselves to activities remunerated with wages, honoraries, salary, or by the day; excepting technicals contracted by the Government of the Republic, by companies or individuals who have previous authorization of the Executive and workers who possess sufficient funds for establishment of a workshop or industry for carrying on business by reasonable computation, having previously consulted and obtained favorable permission of the Executive.

INDIA

1. As there is no registration act in the country, one finds quacks practicing dentistry with little or no dental training. There are two dental colleges organized by the American graduates (Hindus) for imparting scientific dental education. The course is for four years, adopted from the British and American courses. There is an agitation for a registration act and probably it will come within two or three years. Foreign graduates will then have to take an examination for a license to practice dentistry.

2. This new registration act will probably be introduced very soon after the new political reforms are introduced, in 1937. It will probably be along the same line as the Dentist's Act of 1921 of Great Britain, with little modification. In the absence of a registration act, there is no requirement for the practice of dentistry in India at present and it has become a dumping ground for all sorts of foreign professional people.

3. It is advantageous to a foreign dentist to know the vernacular of the province in which he is going to practice.

4. There is no reciprocity with any foreign countries except Great Britain. As American medical and dental colleges have no reciprocity with the outside world and have not tried to establish this connection with Indian universities, it is desirable to approach Indian universities.

ITALY

1. The applicant must have a degree of doctor in medicine and surgery (six years' university training) and a diploma in dentistry and oral prosthesis.

2. He must pass an examination for the degree of doctor of medicine and surgery.

3. Yes.

4. There is no reciprocity as regards the practice of dentistry, but there is reciprocity with England for the practice of medicine and surgery. Anyone authorized to practice medicine and surgery may, with certain additional training, practice dentistry.

JAPAN

1. Any one who wishes to practice dentistry in Japan should be a graduate of a recognized dental school or college. Any person who has graduated from a dental school in Japan where the course of education is three years may be permitted to practice dentistry in Japan on passing the national dental examination. A physician also who has specialized in dentistry and has a permit from the authorities concerned to practice dentistry can practice.

2. A dentist licensed to practice dentistry in the United States should pass the national examination in Japan for dental license, if he wishes to practice dentistry in Japan.

3. A dentist who wishes to practice dentistry in Japan is required to take an examination in all the various subjects in the Japanese language and should be able to talk the language.

4. Japan has reciprocity with only one country; namely, Great Britain.

NORWAY

1. To practice in Norway as a dentist, the Norwegian Dental Examination is demanded. Such examination has to be taken at Norges Tandlaegehoiskole (the dental high school of Norway) after a study of three years. Fifty new students are accepted per annum. Such new students must make a very good record in the entrance examination, matriculation or part I of the official medical examination.

2. A foreign dentist must take the three years' course of study at, and the Norwegian dental examination of, the dental high school. No exceptions are made.

3. By the three years' study at the high school, the person concerned will learn Norwegian well enough to speak and write it perfectly. At the examinations, the Norwegian language only is used.

4. Many Norwegian dentists have taken dental degrees in Germany, England and France, but all have had to take the Norwegian examination.

SAN SALVADOR

1. A college degree from a recognized dental school, plus an oral examination on all dental subjects. A practical examination in prosthetics, crowns and bridgework and a clinical examination in operative dentistry. The applicant must also write an original thesis on any dental subject. The examination fee is $200.

2. Same as above.

3. Yes, Spanish.

4. Reciprocity with Guatemala, Honduras, Nicaragua and Costa Rica.

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MEETING OF THE COMMITTEE ON ECONOMICS

The Committee on Economics will meet in Room 218, St. Francis Hotel, San Francisco, Sunday morning, July 12, at 10 o'clock. All members and deputies are requested to be present and to present their district or state reports.

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OPEN FORUM ON DENTAL ECONOMICS

An open forum on dental economics will be held Wednesday morning, July 15, from 9 to 12 in Parlor 1, St. Francis Hotel, San Francisco. All members interested in dental economics are invited to be present. If you plan to take an active part in the forum, send your name and subject to the Secretary of the Committee on Economics at once, 212 E. Superior St., Chicago, Ill.

### Teeth-By-Mail Ban Is Upheld by U. S. Court

Dec. 16, 1935, the Federal Trade Commission filed an application for enforcement of its order to cease and desist against Ritholz, who was conducting a laboratory in Chicago and engaged in the sale and distribution, in interstate commerce, of dental plates. According to the Commission's findings of fact, Ritholz, through the medium of various kinds of advertising, made extravagant and unwarranted claims concerning the value and properties of such plates, which were made by him from impressions taken by lay persons located in various states, and forwarded by them to the respondent at his Chicago laboratory. The June 2, 1936, *Chicago Tribune* is quoted: "Without leaving the bench, the three judges sitting in the United States Circuit Court of Appeals agreed today to overrule the appeal of Benjamin D. Ritholz and his Chicago Dentists and Chicago Dental House, Inc., from a federal trade commission ruling that they 'cease and desist' extravagant and unsupported claims in advertising their sets of false teeth for sale by mail.

"Judges Evan A. Evans and Will M. Sparks of the Circuit Court of Appeals and Walter C. Lindley of the District court gave the decision. Ordinarily they retire for leisurely consultations before writing and handing down decisions.

"The federal trade commission in 1934 ruled that the Ritholz company's advertising practices were in violation of statutes governing interstate commerce and that they constituted an unfair method of competition."

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### A Bill to Amend the Dental Act, New Brunswick

At the recent session of the New Brunswick Legislature, a bill was introduced to amend the Dental Act. It provided that a new section be added to the Act, by which any person whose name was recorded in the dental register as "Assistant Dentist" and who could establish to the satisfaction of the Council of the New Brunswick Dental Society that he had practiced dentistry as an assistant dentist for a period of six years should be entitled to be registered as a dentist under the act upon payment to the Registrar of the sum of fifty dollars. It was hoped and expected that this iniquitous bill would be thrown out, but how unfortunate it is that the dentists of New Brunswick have to go to the time and expense of fighting such a ridiculous piece of proposed legislation. Then again there is always the possibility of such legislation becoming law, which would not only lower standards in the province immediately affected but would, in regard to precedent, send forth its slimy tentacles into every province of Canada. This is only one more illustration of the immediate urgent need for the effective organization of the Canadian Dental Association.—*J. Canad. D. A.*, May, 1936.

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### Dr. Grubb Appointed Nebraska State Dental Advisor

Gov. Roy L. Cochran, of Nebraska, has just appointed George A. Grubb, dean of the School of Dentistry, University of Nebraska, to represent dentistry on the Advisory Committee for this state under the provisions of the Social Security Act.

# THE COMMITTEE ON ECONOMICS NEEDS FACTS

The Committee on Dental Economics needs facts and figures on the practice of dentistry. There are a number of methods by which this information can be obtained, most of which are extremely costly and time consuming. After considerable deliberation, the committee has chosen this simple, direct and inexpensive method. The success of the venture will depend entirely on your cooperation. Help the Association, help the committee and help yourself by filling out the form below and returning it in a blank envelop *now.*

This information is important in substantiating claims and making comparisons. It will be the exclusive property of the American Dental Association. *You will not be identified in any way.*

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MAIL PROMPTLY TO THE SECRETARY, COMMITTEE ON ECONOMICS, AMERICAN DENTAL ASSOCIATION, 212 EAST SUPERIOR STREET, CHICAGO, ILLINOIS

Number of years in practice of dentistry_____ Age_____

In general practice_____ or specialized in_____

Gross income from practice in 1935 $_____ 1932 $_____

Total office expenses in 1935 $_____ 1932 $_____

Office rent 1935 $_____ 1932 $_____

Office assistant's salary 1935 $_____ 1932 $_____

Net income from practice 1935 $_____ 1932 $_____

Loss from bad credits 1935 $_____ % 1932 _____ %

The present value of my strictly dental equipment is approximately $_____

The area in which I practice is largely, agricultural, commercial, manufacturing, residential. (Underline)

Population of town in which I practice_____

Name of state_____ Number of dependents_____

*DO NOT SIGN*

# CURRENT LITERATURE

*Changes in Incisor of Thirteen-Lined Ground Squirrel (Citellus Tridecemlineatus) Following Bilateral Gonadectomy (I. Schour, Anat. Rec., 65:177, 1936):* This study was made on twenty-six gonadectomized animals whose ages ranged from 2 to 14½ months and whose survival periods were from twenty-five to 339 days. The results were charted and based on three factors: (1) the amount of organic matter in the enamel, (2) the zoning of the dentin and (3) the presence of osteoid tissue in the alveolar border. In twenty of the twenty-six animals some degree of disturbance was noted. Roentgenograms revealed an opacity ranging from normal to a mere shell-likeness. Fractures were noted in some of the more disturbed cases. The histologic picture showed a flattening of the ameloblasts with round-cell infiltration in places; dentin composed of globules and with wide zones of predentin; an invasion of capillary loops about the odontoblasts; the presence of abnormal amounts of enamel matrix, and of abnormal amounts of osteoid tissue in its alveolar border. Dr. Schour compares his observations with the picture presented by rickets, and the effects of gonadectomy on the teeth of other animals. The explanations offered for this disturbed calcification are: 1. Gonad removal may disturb dietary factors essential for normal calcification so that they are not utilizable. 2. The gonads of the ground squirrel have a direct calcific influence. 3. Gonad removal may produce rickets. 4. Gonad removal may influence other endocrine glands, which, in turn, effect calcification.

M. W. McCrea.

*Congenital Bony Temporomandibular Ankylosis and Facial Hemiatrophy (L. W. Burket, J.A.M.A., 106:1719 [May 16] 1936):* The author reviews the literature dealing with bony intra-articular temporomandibular ankylosis discovered in the early years of life, and reports one case in detail. Diagnosis is usually made on the basis of developmental inequality of the two sides of the face if the condition is of long duration, although a roentgen-ray examination is necessary to establish the diagnosis and to determine the extent and location of bony union, if one exists. It is generally felt that infection or trauma causes this rare condition. Arthroplasty of the temporomandibular joint, with interposition of a flap of tissue to prevent reankylosis is the accepted treatment today. The case reported was of a full-term, spontaneously delivered male infant showing true congenital bony ankylosis in the region of the left temporomandibular joint and alveolar ridges associated with maxillary and mandibular hemiatrophy. Labor was not abnormal, but a moderate excess of amniotic fluid was present. Twenty-four hours after birth, lysis of the fibrous and bony fixation was performed, which permitted fairly near normal mandibular movements. Bony ankylosis recurred in two months, but a sufficient anterior aperture remained to permit feeding. It is possible that reankylosis could have been prevented by insertion of a fascial or muscular slip between the bony fragments. Provided adequate nutrition can be maintained, further operative procedures are not planned, until the patient is 5 or 6 years old. At that time, orthodontic treatment will be practiced as an aid in promoting further development of the ankylosed side of the face.

M. K. Hine.

*Pathologic Fractures Due to Malignant Disease (Claude E. Welch, Surg. Gynec. & Obst., 62:735 [April] 1935):* Thirty years ago, surgeons regarded pathologic frac-

tures without hope. Grunert, in 1904 and Cotton, in 1911, stated that, in true carcinomatous metastases, union of the fragments seldom if ever occurs. Bloodgood, Scudder and Codmen were of the same opinion. Since then, many reports of healed pathologic fractures have appeared in the literature. Rypins and Gobbi have reported several cases. Pancoast, quoted by Eliason, believes that 40 per cent of cases of pathologic fracture due to cancer heal. Eliason emphasizes the poor prognosis, which he says is similar to that of sarcoma. Coley reviewed 122 cases of ostegenic sarcoma in which there were twenty-six pathologic fractures. In this series, union never occurred. There were thirty-six cases of endothelial myeloma, of which 26 per cent (nine cases) showed fractures. Union was obtained in three cases. The author describes in detail roentgen therapy as applied to pathologic fractures. There are several cases reported, including one that was diagnosed on admission to the hospital as carcinoma of the buccal mucosa with metastases in the neck.

J. Frank Hall.

*Surgical Repair of Facial Nerve (R. C. Martin, Arch. Otolaryngol., 23:458 [April] 1936):* In a discussion of the procedures designed to correct facial paralysis following operations on the mastoid, the author reports employing direct anastomosis, apposition of the ends of the nerve without suturing and interposition of a homogenous nerve graft successfully in three cases. Case histories and photographs accompany the article. The author points out that a patient who has had the facial nerve repaired must be reeducated in emotional control of facial muscles. In no case did the functions of the frontal muscle return. In a discussion of the paper, Sterling Bunnell reported repair of four cases. Although nerve grafts of the facial nerve are successful, he states his belief that in most instances in which the nerve is injured in mastoidectomy, the gap in the nerve can be closed by rerouting and that, when its use is possible, this method is preferable.

M. K. Hine.

*Infections of Parotid Gland (W. H. Hobbs and H. Sneierson, Am. J. Surg., 32:258 [May] 1936):* The consensus of opinion holds to the ascending rather than hematogenous method of infection of the parotid. The authors treat infections of these glands by carefully dilating and irrigating with a physiologic sodium chlorid solution. Fluids are forced and the patient is encouraged to massage the gland mildly by frequent opening and closing of the mouth. The use of radium packs is considered of the same value here as elsewhere in the body. Reports on five cases are given in detail. The technic for making sialograms is given, together with twenty-two plates showing normal and abnormal glands in sialograms and in drawings made from them.

Hamilton Robinson.

*Medical Aspects of Periodontoclasia and Gingivitis (J. C. Healy, F. H. Daley and M. H. Sweet, J. Lab. & Clin. Med., 21: 688 [April] 1936):* In the study of periodontoclasia and gingivitis, the physician and the dentist have two important objectives: consideration of the probable deleterious effects on general health and the etiology of the condition. Certain cases are acute, and some of these are of bacterial origin and curable by local treatment. The authors feel that the majority of acute and all subacute and chronic cases are not of the infective type. Local or general arteriosclerosis may be the sole cause, a complicating factor or the end-result of the common pathogenesis of periodontoclasia. Blood dyscrasias may deplete the tissues in an analogous manner. In the study conducted, leukocytic counts were made on the blood from the gingiva and from the finger type and ear lobe of each patient. In most cases of gingivitis, some etiologic condition is intimately concerned with systemic dysfunction, Daley has concluded. Some form of allergic disease was revealed through studies of the histories of forty-six of the 123 patients considered. Canker or soreness of the gums followed the eating of some particular food in allergic cases. The authors noted that those

cases which they considered of allergic nature showed common diagnostic features: eosinophilia, capillary dilation, increased permeability and exudation.

HAMILTON ROBINSON.

*Granulocytic Angina—a Report of Three Cases with Two Fatalities (Iva Frank, Arch. Otolaryngol., 23:310 [March] 1936):* A review of recent literature on granulocytopenia and granulocytic angina is given. The author concludes that granulocytopenia may have a number of causes, among which use of the drugs of the coal tar series may be included. Histories of three cases are given, one of which was first diagnosed and treated as a Vincent's infection. Fusiform bacteria and spirilla were reported present in two cases. As decreased resistance of the host facilitates the spread of infection everywhere, especially in the mouth and throat, where the fusiform bacteria and oral spirilla are usually present, a soreness of the mouth and throat are frequent, though not constant, results of granulocytopenia.

M. K. HINE.

*Manifestations of Leukemia Encountered in Otolaryngologic and Stomatologic Practice (A. A. Love, Arch. Otolaryngol., 23:172 [Feb.] 1936):* The author calls attention to the fact that the four outstanding landmarks causing one to suspect a blood disease (anemia, enlargement of lymph glands, hemorrhage into the tissue or from mucous surfaces and throat lesions, particularly of the membranous or ulcerative types) may be apparent on examination of the structures above the shoulders. Accordingly, he discusses the involvements of the ear, nose, mouth, throat, larynx and neck due to leukemia. Twenty-four case histories are presented to illustrate the leukemic lesions in these areas. The author points out that the pathologic changes in the oral cavity are varied. In some patients the gums are pale and of normal contour; in others, hypertrophied and spongy. Bleeding of the gums is probably the most constant factor, although areas of necrosis on the buccal and labial surfaces of the gums, cheeks and lips are often found. In many cases, continuous and uncontrollable hemorrhage following extraction of teeth gives the first clue to leukemia. In other patients, fever, angina, bleeding of the gums, adenopathy and loss of weight and strength should suggest leukemia. In investigating a case of necrotic gingivitis, one should always keep in mind the possibility of some serious underlying pathologic conditions, which must be eradicated before the gums will respond to local treatment. To illustrate this, the case history is given of a man who was treated for Vincent's infection for forty-eight days before a diagnosis of myelogenous leukemia was made. Seventeen pictures and an extensive bibliography accompany the article.

M. K. HINE.

*Liposarcoma of Bone (D. J. Rehbock and H. Hauser, Am. J. Cancer, 27:37 [May] 1936):* Liposarcoma may be primary in the bones and metastases to the cranium are common. The two cases presented by the authors, confirmed at necropsy, seemed to have originated in the bones. It is of interest to note that, in one instance, a clinical diagnosis of chronic arthritis was first made, being attributed to numerous infected teeth.

HAMILTON ROBINSON.

*Melanomas (D. H. Affleck, Am. J. Cancer, 27:120 [May] 1936):* The melanomas include benign forms, the pigmented nevi and malignant types, melanosarcoma, melanocarcinoma or malignant melanoma. Occasionally, the benign type may undergo malignant proliferation. The benign melanomas are found most commonly on the face and neck (39 per cent), then on the back, chest, upper extremities, abdomen and lower extremities and occasionally on the mucous membrane of the nasal cavity or in the anorectal region. Many of these are congenital nevi. Of 317 cases of malignant melanoma, 266 gave histories of primary pigmented moles. The highest incidence of these malignancies is in areas of trauma. The clinical onset may be characterized by an enlargement of the regional lymph nodes, or there may be enlargement and ulceration of the primary mole. The

removal of pigmented nevi in their quiescent stage is recommended. When a nevus shows sufficient symptoms to cause a patient to seek medical advice, it is usually in an advanced stage, where treatment rarely results in cure. Metastasis may take place by the blood stream or lymphatics.

HAMILTON ROBINSON.

*Aloe Vera in Treatment of Roentgen Ulcers and Telangiectasis (C. S. Wright, J.A.M.A., 106:1363 [April 18] 1936):* The use of fresh whole leaf of a plant, aloe vera, as a treatment was suggested early in 1935, by C. E. and Creston Collins, after a case of severe roentgen dermatitis of the forehead had been treated by it. The patient received a local application of fresh whole leaf of aloe vera, and, in twenty-four hours, the sensation of burning and itching subsided. The condition improved, and, after five weeks, showed complete healing without a scar. The author reports two cases of ulceration caused by the roentgen rays and in which healing followed the application of aloe vera. These cases were of three and two years' duration. Seven cases of telangiectasis showed smoothing and softening of the affected skin, although the degree of telangiectasis was not lessened. The author concludes that, in view of the unfortunate occasional burns resulting from overexposure to the roentgen rays, any therapeutic agent that offers a hope of quick healing and relief of discomfort is worthy of further study.

M. K. HINE.

*Glossodynia (S. F. Gilpin, J.A.M.A., 106:1723 [May 16] 1936):* The author reviews the literature on glossodynia and reports statistics on forty-eight cases seen at The Mayo Clinic. Of the forty-eight patients, thirty-seven were women, and thirty-five were more than 50 years of age. The average age was 54.3 years, the range being from 20 to 73 years. No relation to migraine was noted and gastric acidity was normal in the sixteen cases tested. The incidence of mental depression was found to be slightly higher in those suffering from glossodynia than in the general population. There was also a high incidence of psychoneurotic symptoms accompanying this condition, suggesting to the author that perhaps glossodynia is sometimes a psychoneurotic manifestation. In eleven of the forty-eight cases, there were evidences of arteriosclerosis. Twelve of the patients were completely edentulous, and twenty mostly so. Local treatment apparently is of no avail, but relief may result from various forms of psychotherapy.

M. K. HINE.

*Accident Insurance: Extraction of Tooth as "Surgical Treatment" (Medicolegal abstracts, J.A.M.A., 106:1597 [May 2] 1936):* The defendant insurance company issued a policy to Mrs. Carroll providing certain benefits for "loss resulting directly and independently of all other causes from bodily injuries effected . . . solely through external violent and accidental means." The policy excluded from coverage "accident, injury, death or other loss caused directly or indirectly by medical or surgical treatment." In treating the insured for pyorrhea, a dentist extracted a tooth. Acute gangrenous cellulitis developed, from which the insured died. The beneficiary named in the policy recovered judgment against the defendant insurance company, and an appeal from that judgment was eventually determined by the Commission of Appeals of Texas, section A. While the extraction of the insured's tooth, said the Commission of Appeals, constituted the accidental means whereby the death of the injured was caused, and was external and violent, yet the extraction constituted "surgical treatment." Hence, the death was not covered by the policy. The judgment in favor of the beneficiary was accordingly reversed, and judgment given for the insurance company. This opinion of the Commission of Appeals was adopted by the Supreme Court. (Century Indemnity Company v. Carroll [Texas] 86SW [2nd] 1083.)

## FOREIGN LITERATURE

*Treatment of Hemorrhagic Diseases, Part II (H. Letheby Tidy, Brit. M. J., 3930:895 [May 2] 1936):* The author continues the classification and discussion of

hemorrhagic disease. Symptoms and diagnosis are explained and treatments for each are given. Such diseases as anaphylactoid, or secondary, purpura; hemorrhagic deficiency disorders, such as scurvy and neonatorum, and hereditary hemorrhagic disorders, such as hemophilia, diathesis and capillary telangiectasis, are dealt with. The blood diseases of especial interest to the dental profession taken up in this discussion are hemophilia and hereditary capillary telangiectasis. For hemophilia, there is no known cure. A blood transfusion of from 300 to 500 c.c. should always be undertaken immediately before any operative procedure. The injection of whole blood intramuscularly may reduce the coagulation time, but is less definite than the effect of blood transfusion. It has an advantage in that it is not necessary for the injected blood to be of the same type as the recipient's. The use of horse serum, calcium, liver extract, estrogenic hormones, epinephrine, cevitamic (ascorbic) acid and snake venom are considered as general treatment. Topical treatment is employed for local hemorrhage. In hereditary capillary telangiectasis, fragile nevi of various shapes and kinds develop in the skin and mucous membrane, probably owing to congenital weakness of the capillary endothelium. The nevi rupture and produce anemia. Many of the patients finally die from a slowly advancing anemia.

J. FRANK HALL.

*Assessment of Dental Sepsis as Affecting Medical and Surgical Procedures (A. Bulleid, Lancet, April 25, 1936):* Bacteriologic studies on over 1,000 pulpless teeth indicated that a streptococcic infection was present. Four hundred of these teeth presented apical granulomas from which were isolated streptococci, usually the viridans type. Several cases are cited in which eradication of such oral conditions improved a systemic condition. The author shows that in a "closed" condition, such as an apical involvement, there is usually infection. An "open" condition, such as pyorrhea, usually produces a slight change in the blood picture. He believes that a bacteriologic investigation is very important in determining the source of the condition. From his study, he states that pulpless teeth should not be tolerated and that the streptococcic overload should be eradicated by a conservative method if possible. Also, he believes that oral streptococcic conditions should be eliminated before surgical procedures are undertaken.

M. W. MCCREA.

*Synthetic Ligature Material (H. J. v. Brandis, Zentralbl. f. Chir., Feb. 15, 1936, p. 372; by W. Konig, ibid., p. 377, via Brit. M. J., 3930:72 [May 2] 1936):* This new suture material, described as a polymeric compound of vinyl alcohol, is a reversible colloid like hemoglobin or globulin. Its tensile strength is greater than that of catgut, although it is not absorbable by the tissues. The threads are produced at a temperature of 130 to 140 C. under a pressure of 100 to 150 atmospheres; which makes it an unquestionably sterile suture and ligature material.

J. FRANK HALL.

*Malignant Tumors of Base of Tongue (J. and L. Ducuing, Lyon chir., 32:641-683 [Nov.-Dec.] 1935 via Surg. Gynec. & Obst.):* The problem of cancer of the base of the tongue is dominated by the localization of the infection, the anatomy of the lymphatics and the technic of irradiation. Malignant tumors of the base of the tongue are essentially cancers of the pharynx. Early symptoms are often absent and, when manifested, are generally accompanied by submaxillary, carotid and retropharyngeal adenopathy. Better results are obtained with irradiation than with surgical measures, according to the author. Five cases are cited in which radon therapy, assisted by other methods, has effected cures. The condition was greatly improved in a number of other cases.

J. FRANK HALL.

# MISCELLANY

## BOOK REVIEW

*Your Breath and Your Health.* By Louis M. Pearlman, M.D., Chief of Ear, Nose and Throat Clinic, Harlem Dispensary (1925-1935); Member Vienna A.M.A.; Formerly Captain Medical Reserve Corps; Fellow American Medical Association; Member New York State and County Medical Societies. Illustrated, 128 pages, price $1. Published by the Academy Publishing Company, New York City, 1936.

The importance of a wholesome breath to the dentist cannot be overestimated, and thus this book must make an unusual appeal to the profession. The play on "halitosis" fostered by commercial agencies has no place in a book like this, wherein is presented a serious minded consideration of the nature, cause and effect of bad breath. A clear and satisfactory exposition is made of the conditions leading to bad breath, and the sane and logical treatment of the affections that tend to bring about a departure from the normal, together with the proper procedures for bringing about normality and eliminating the untoward symptoms.

It is in every way a most satisfactory volume, and is not padded to suffocation as many volumes are.

## NEWS

*Vermont Society Elects Officers:* Following are the newly elected officers of the Vermont State Dental Society: president, C. Ives Taggart, Burlington; first vice president, Edward B. Jenney, Rutland; second vice president, Carl B. Webster, Orleans; secretary, Howard Reid, Barre; treasurer, Thomas A. Norton, Rutland; executive committee, W. Fay Mann, Jr., Barre; Max L. Jameson, Burlington; Harold Spear, Swanton.

*New Dental School of University of Illinois:* June 4, 1936, Frederick L. Noyes, dean of the College of Dentistry and other officials of the University of Illinois laid the corner stone for the university's new $1,457,000 medical and dental school. A. C. Willard, president of the university, made the ceremonial address. He stated that the new building would enable the university to fulfil more completely its obligations to the people of the state and the nation in providing better medical and dental education.

*Dr. Blayney Director of Clinic:* Announcement has been made of the appointment of James R. Blayney as director of the Walter G. Memorial Dental Clinic at the University of Chicago, which was made possible by a bequest of $2,900,000. Dr. Blayney was recently made professor of dental surgery at the University of Illinois College of Dentistry.

## DEATHS

*Adams, Frank Eugene,* Portland, Ore.; died May 2; aged 69.

*Armstrong, Herbert R.,* New York City; New York College of Dentistry, 1894; died May 2.

*Brown, L. Parmly,* Peekskill, N. Y.; Baltimore College of Dental Surgery, 1889; was killed in an automobile accident, May 11.

*Burmester, Henry E.,* North Bend, Ore.; North Pacific College of Oregon, School of Dentistry, 1905; died April 17; aged 53.

*Newton, Daniel B.,* Lansing, Mich.; University of Michigan, College of Dental Surgery, 1917; died April 7; aged 43.

*Scofield, Frederick E.,* Brooklyn, N. Y.; New York College of Dentistry, 1881; died April 19.

*Thornton, L. M.,* Portland, Ore.; died May 2; aged 64.

# ANNOUNCEMENTS*

## CALENDAR OF MEETINGS

American Dental Association, San Francisco, July 13-17.

American Academy of Periodontology, San Francisco, July 9-11.

American Association of Dental Editors, San Francisco, July 11.

American Academy of Restorative Dentistry, San Francisco, July 11-12.

American College of Dentists, San Francisco, July 12.

American Society for the Promotion of Dentistry for Children, San Francisco, July 13-14.

American Society of Oral Surgeons and Exodontists, San Francisco, July 10-11.

Association of American Women Dentists, San Francisco, July 13-17.

American Dental Society of Europe, August, 1937.

Greater New York Meeting, December 7-11.

International Association for Dental Research (San Francisco Section), San Francisco, July 13.

International Dental Congress, Vienna, August 2-8.

Texas-Oklahoma-Dallas County, Dallas, August 31-September 4.

Society for the Advancement of General Anesthesia in Dentistry, New York City, third Monday in February, April, October and December.

District of Columbia at George Washington University, Washington, D. C., second and fourth Tuesdays in each month from October to June, inclusive.

British Empire Dental Meeting, London, July.

Montreal Dental Club and Canadian Dental Association, Montreal, October 14-16.

American Dental Hygienists' Association, San Francisco, July 13-17.

American Dental Assistants Association, San Francisco, July 13-17.

## STATE SOCIETIES

July

Colorado, at Denver (6-9)

Wyoming, at Sheridan (13-14)

August

Texas, at Dallas (31- September 4)

September

Southern California, at Los Angeles (21-23)

October

Florida, at Orlando (5-7)

November

Puerto Rico, at Mayaguez

May

Illinois, at Springfield (11-13)

## STATE BOARDS OF DENTAL EXAMINERS

Arizona, at Flagstaff, August 3. R. A. McCall, 719 Professional Bldg., Phoenix, Secretary.

New Jersey, at Trenton, December 7-12. State Board of Registration and Examination in Dentistry, 148 W. State St., Trenton.

North Dakota, at Fargo, July 14-17. W. E. Cole, Bismarck, Secretary.

## ILLINOIS STATE DENTAL SOCIETY

The Illinois State Dental Society will hold its seventy-third annual meeting at Springfield, May 11-13.

BEN H. SHERRARD, *Secretary,*
300 Rock Island Bank Bldg.,
Rock Island.

## GREATER NEW YORK DECEMBER MEETING

The Twelfth Greater New York December Meeting will be held December

*Announcements must be received by the fifth day of the month in order to be published in the forthcoming issue of THE JOURNAL.

7-11 at the Hotel Pennsylvania, New York City.

GEORGE C. DOUGLASS,
Room 106A,
Hotel Pennsylvania,
New York City.

MONTREAL TWELFTH ANNUAL FALL CLINIC

The Montreal Twelfth Annual Fall Clinic, under the auspices of the Montreal Dental Club, will be held at the Mount Royal Hotel, Montreal, October 14-16. The annual meeting of the Canadian Dental Association will be held in conjunction with the Clinic. Membership reservations are now being accepted by the treasurer, F. A. Edward, 910 Medical Arts Bldg., Montreal. The fee to nonresidents is $5, including two luncheons.

J. K. CARVER, *Publicity Chairman,*
394 Victoria Ave,
Westmount.

## ILLINOIS STATE DENTAL SOCIETY SPECIAL TRAIN TO SAN FRANCISCO

Members of the American Dental Association and their friends who will attend the Seventy-Eighth Annual Session at San Francisco are invited to avail themselves of the unsurpassed cross-continent travel service provided by joining the special train party arranged by the Illinois State Dental Society via the Chicago & Northwestern Railway—Union Pacific Railroad—Southern Pacific Lines.

The special train will follow the route of the famous "San Francisco Overland Limited," the shortest and most direct route to the Convention City, and will afford an opportunity to meet many old friends and form new acquaintances en route.

Nothing will be left undone to make the trip interesting, restful and enjoyable. Every courtesy will be shown by an experienced train personnel. Modern, all-steel equipment, sleep-inviting berths, excellent meals and a transcontinental route of unusual historic interest and diverse scenic beauty will make travel hours pass pleasantly and quickly.

The finest equipment of the Union Pacific lines will be available. This trip by special train is not to be confused with any of the various "convention tours" offered, which use only tourist coaches and are not air-conditioned.

The Illinois State Dental Society Special will have the most modern type all steel, air-conditioned equipment, including drawing rooms, compartments and open section sleeping cars and observation-lounge car, with barber, bath, valet and maid service. The dining car will serve popular low "select your price" meals, with breakfast from 50 cents to $1, luncheon, 75 cents to $1, and dinner, $1 to $1.25, as well as popular a la carte service.

*Special Train Schedule*

Lv. Chicago..... 9:45 P.M. (C.T.)
Friday, July 10—C. & N. W. Ry.
Ar. Omaha..... 10:00 A.M. (C.T.)
Saturday, July 11—C. & N. W. Ry.
Lv. Omaha..... 10:45 A.M. (C.T.)
Saturday, July 11—Union Pacific.
Ar. Ogden..... 9:20 A.M. (M.T.)
Sunday, July 12, Union Pacific.
Lv. Ogden..... 9:00 A.M. (P.T.)
Sunday, July 12—Southern Pacific.
Ar. San Francisco..... 8:32 A.M. (P.T.)
Monday, July 13—Southern Pacific.

*Train Fares*

Exceptionally low excursion fares will be available for this occasion. Such tickets will be on sale daily from May 15 to October 15, permitting stopover at any point en route within the final limit of October 31, and may be routed via the special train direct to San Francisco, returning via the route of choice. This low round trip fare from Chicago will be $86, with correspondingly low fares from all other points.

Railway representatives will be glad to quote specific fares from the passenger's home town.

*Pullman Fares*

Chicago to San Francisco, will be as follows:

| Lower Berth | Upper Berth | Section for Single Occupancy | Compartment | Drawing Room |
|---|---|---|---|---|
| $15.75 | $12.60 | $22.05 | $44.50 | $56.00 |

NOTE: Minimum of one and one-half tickets is required for the occupancy of a compartment and two tickets for the occupancy of a drawing room, in addition to regular sleeping car ticket.

Via the scenic and historic Overland Route, the journey will prove to be a most fascinating one. If time permits, may we suggest that, on the return trip, advantage be taken of the stopover privilege the ticket entitles the traveler to, visiting one or more of the many points of interest, or perhaps enjoying an outing in one of the many vacation regions that the West so generously provides.

Information regarding Yellowstone Park, Boulder Dam, Yosemite Park, Zion-Grand Canyon, Glacier Park or Canadian Rockies, Lake Louise and Banff may be had for the asking. The costs for first class travel are surprisingly low.

Further detailed information may be had by writing

GEORGE W. HAX, *Chairman of Transportation,*
Illinois State Dental Society,
8 So. Michigan Ave.,
Chicago, Ill.

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